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A SUMMARY OF SELECTED DATA: DSDP LEGS 1-19.(U)
SEP 80 E C SNOW, J E MATTHEWS
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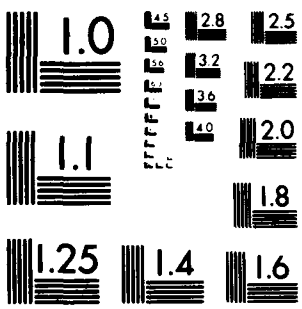


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Forward

This report is a presentation of data from the first 44 legs of the D/V GLOMAR CHALLENGER, a deep-ocean drill ship operating under the direction of the Deep Sea Drilling Project. The selection of parameters presented and the graphic format were designed to convey a summary view of the inter-relationships between [illegible], lithologic, and physical property data as a first step in the synthesis of this information in support of geoacoustic modeling.

C. [illegible], [illegible]
Commanding Officer
[illegible]

Executive Summary

Deep ocean sediment cores recovered by the drill ship D/V GLOMAR CHALLENGER have provided invaluable "boundary conditions" for the interpretation of marine seismic reflection and refraction data. In combination, these data provide much of the basis for constructing geoacoustic models in support of low-frequency acoustic propagation in the deep ocean. This report provides a concise, graphic correlation between vertical reflection seismic records across the drill holes, and lithologic-physical property data measured from the drilled cores. This correlation and condensation in a standardized format is the first step in producing a synthesis of the data, which will provide insight into the correlation between lithologic and acoustic properties of marine sediments. As stated, this data presentation is only the first step of a synthesis, and interpretation has been minimized. The material is being published at this time in the belief that the condensed data presentation is of immediate value to many people independent of the author's ultimate objective. A detailed discussion of terminology and measurement technique is provided for users from outside the geoscience discipline.

Acknowledgements

It is readily apparent that a major portion of this publication is the graphic representation of data. Foremost in making this project possible was Renee Edman, NORDA Scientific Illustrator. Her continued advice and suggestions throughout the entire process, in addition to her illustrations, were indispensable. The authors are greatly indebted to her for these contributions.

We are grateful to the Deep Sea Drilling Project (DSDP) A-031, University of California, Scripps Institution of Oceanography, for making the data available. The project was further aided by the following people at DSDP. Barbra Long assisted in preliminary planning and provided information on data availability. Peter Woodbury developed the methods of presentation and use of computer programs for the physical properties and lithologic plots. Tom Birtley and Nancy Freelander accomplished the organization and plotting of those data.

Chris Brown of the NSTL Photographic Laboratory printed the pho')graphs. The text was typed by I. . L)ain and edited by Linda McRaney, ooth f NORDA. Peter Fleischer critically rev.ewed the manuscript. This project was funded by Naval Electronics Systems Command (NAVELEX) Code 320.

Contents

A Summary of Selected Data: DSDP Legs 1-19

I. Introduction

Project Mohole demonstrated that the drilling techniques so highly developed by the petroleum industry could be extended to deep ocean water depths. It also demonstrated that an exploratory program of ocean sediment and upper basaltic layer drilling would require a different type of platform from that required to penetrate to the upper mantle. As a result, the National Science Foundation (NSF) proposed to the United States Congress in 1963 that an "Ocean Sediment Coring Program" be initiated separately from the Mohole Project. To pursue this endeavor, four oceanographic institutions joined to form the Joint Oceanographic Institutions for Deep Earth Sampling (JOIDES), with initial funding by NSF in fiscal year 1965. These efforts resulted in the construction of the drill ship D/V GLOMAR CHALLENGER by Global Marine Inc., with design capabilities of drilling a 2500 ft hole in 20,000 ft of water.

On 16 August 1968, a 2528 ft hole was completed in 9275 ft of water at 25° 51.5'N and 92°11.0'W in the Gulf of Mexico. This was the initial drill hole of the NSF-Funded Deep Sea Drilling Project (DSDP). GLOMAR CHALLENGER proceeded to complete 44 drilling legs (a total of 394 holes) under the direction of DSDP. After Leg 44, NSF funding was augmented by funds from other nations and GLOMAR CHALLENGER continued to drill, but under the direction of the International Program of Ocean Drilling (IPOD). This phase of the program added Legs 45-69, and was continued until October 1979. Current plans are to extend the exploratory drilling program to August 1981 with Legs 70-82. With eleven years of drilling completed, and all ocean drilled (with the exception of the Arctic Ocean), there is now a growing trend toward drill data syntheses on both regional and global scales.

The compilation of data presented in this publication was to provide a foundation for a synthesis directed toward deep-sea geoacoustic modeling. To produce such a synthesis, however, the vast amount of data available from DSDP had to be sorted, condensed, and formated to allow data relevant to one specific purpose to be assimilated. A further consideration was that a synthesis of data from a continuing project must have a data "cut-off" point. This investigation, therefore, is limited to data from only the DSDP phase of the drilling program (Legs 1-44), a point chosen because it was an organizational break in the program, and because the detailed data of the first half of the drilling program is now published and readily available in the Initial Reports of the Deep Sea Drilling Project (hereafter referred to as Initial Reports).

The data presented were obtained directly from DSDP in the form of digital magnetic tapes, computer plots and 35 mm microfilm, while the descriptive paragraphs were summarized from discussions in the Initial Reports. The selection of data to present and the presentation format were designed to convey a summary view of the interrelationship between seismic, lithologic, and physical properties. The data presentation and discussion follow the form of the Initial Reports wherever possible, and are discussed in the section entitled Explanatory Notes. Portions of the Explanatory Notes quoted directly from

the Initial Reports are indicated by a different type style and referenced.

II. Explanatory Notes

A. Key to Illustrations

The majority of this publication consists of a graphic presentation of data collected by the D/V GLOMAR CHALLENGER. Figure 1 is a sample drill hole illustration from Section V. The numbers are keyed to the descriptions which follow. Figure 2 defines the patterns used for presenting induration, lithology and cored interval of columns 7-10 of Figure 1.

(1) Seismic record of region showing location of drill site.

(2) Scale of two-way travel time, in seconds.

(3) Seismic record with right-hand edge cropped at drill site location.

(4) Two-way travel time picks, in seconds, of prominent reflecting horizons. Some that are not readily apparent on the photo copy of the seismic record are taken from the Initial Reports.

(5) Interval velocity of correlated seismic travel time to drilled lithogic-depth. Velocity values are taken from the Initial Reports and are computed directly from the interval (time and depth). Velocities are not given where correlations or values were questionable.

(6) Interface picks, in meters, at discontinuities in lithology taken from the Initial Reports or determined from the core data directly.

(7) (8) (9) (10) Lithologic data are presented in four columns (Fig. 2). Column (7) indicates the degree of sediment induration. The scale is divided into soft, firm, and hard, and represents a qualitative assessment of penetrometer data. Column (8) indicates the composition as calcareous, siliceous, detrital, and igneous. Column (9) indicates the mode of deposition and includes pelagic, transitional, and terrigenous. Column (10) shows the cored intervals.

(11) Geologic age, series or stage boundaries are indicated by tick marks (see Time Stratigraphic Framework, Section II.B.2.e.).

(12) Drill depth, scale in meters.

(13) Sand content is plotted with percentage increasing to the right, while clay is plotted with percentage increasing to the left. Silt content is represented by the remaining area between the curves (see Grain Size Analyses Section II.B.2.a.).

(14) Calcium carbonate content is plotted with percentage increasing to the right, while silica content is plotted with percentage increasing to the left. The remaining area is material other than calcium carbonate or silica. Since these two factors were measured by different means, they have been normalized not to exceed 100% (see Carbonate and Silica Analyses, Section II.B.2.b. and c.).

(15) Sound velocity measurements taken in core samples are plotted increasing to the right. The scale ranges from 1.5 km/sec to 4.0 km/sec, with values outside this range plotted on the boundaries.

(16) Measured porosity values are plotted increasing to the left, with the scale ranging from 40% to 90%. Values below 40% are truncated.

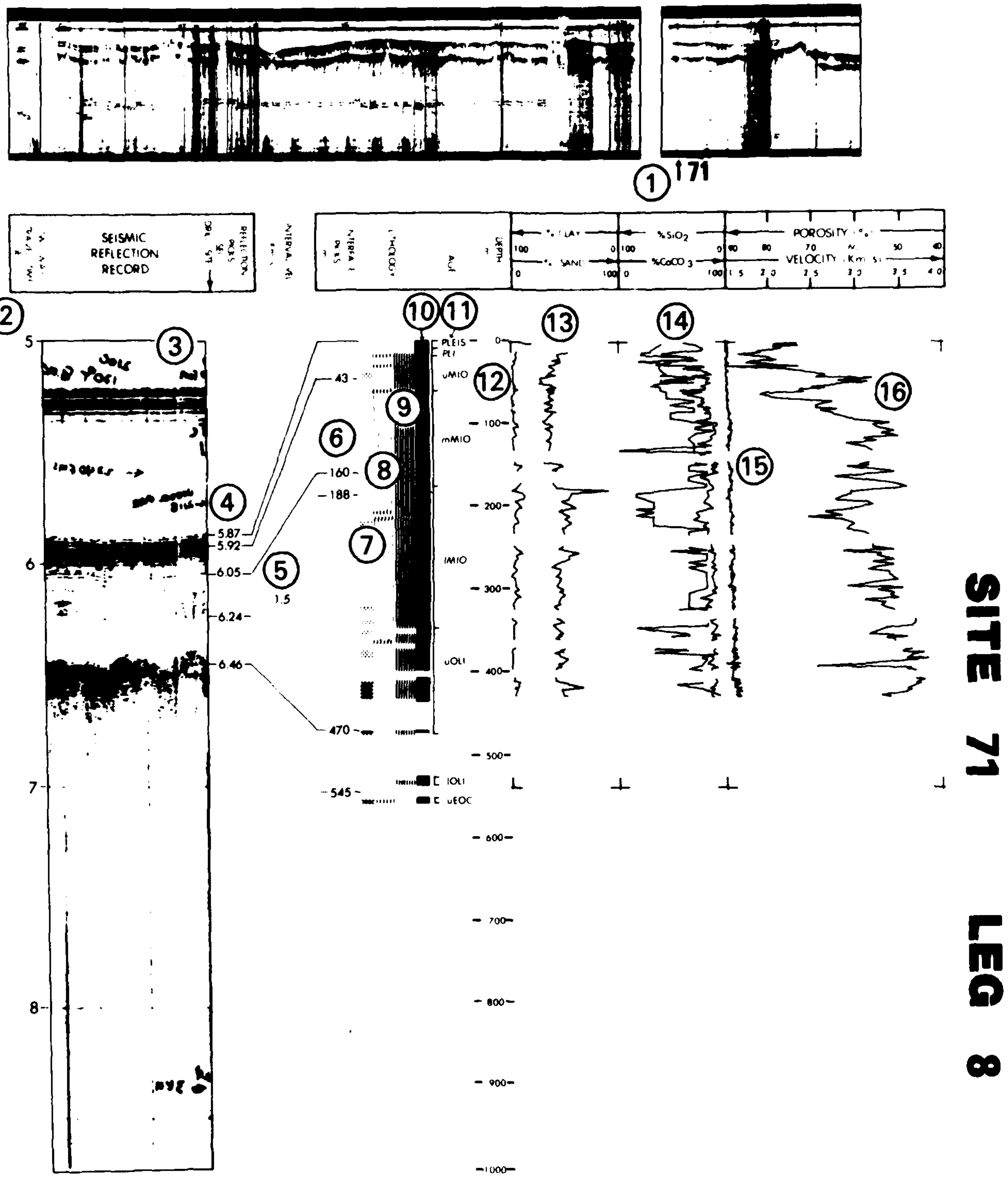


Figure 1. Key to data summaries

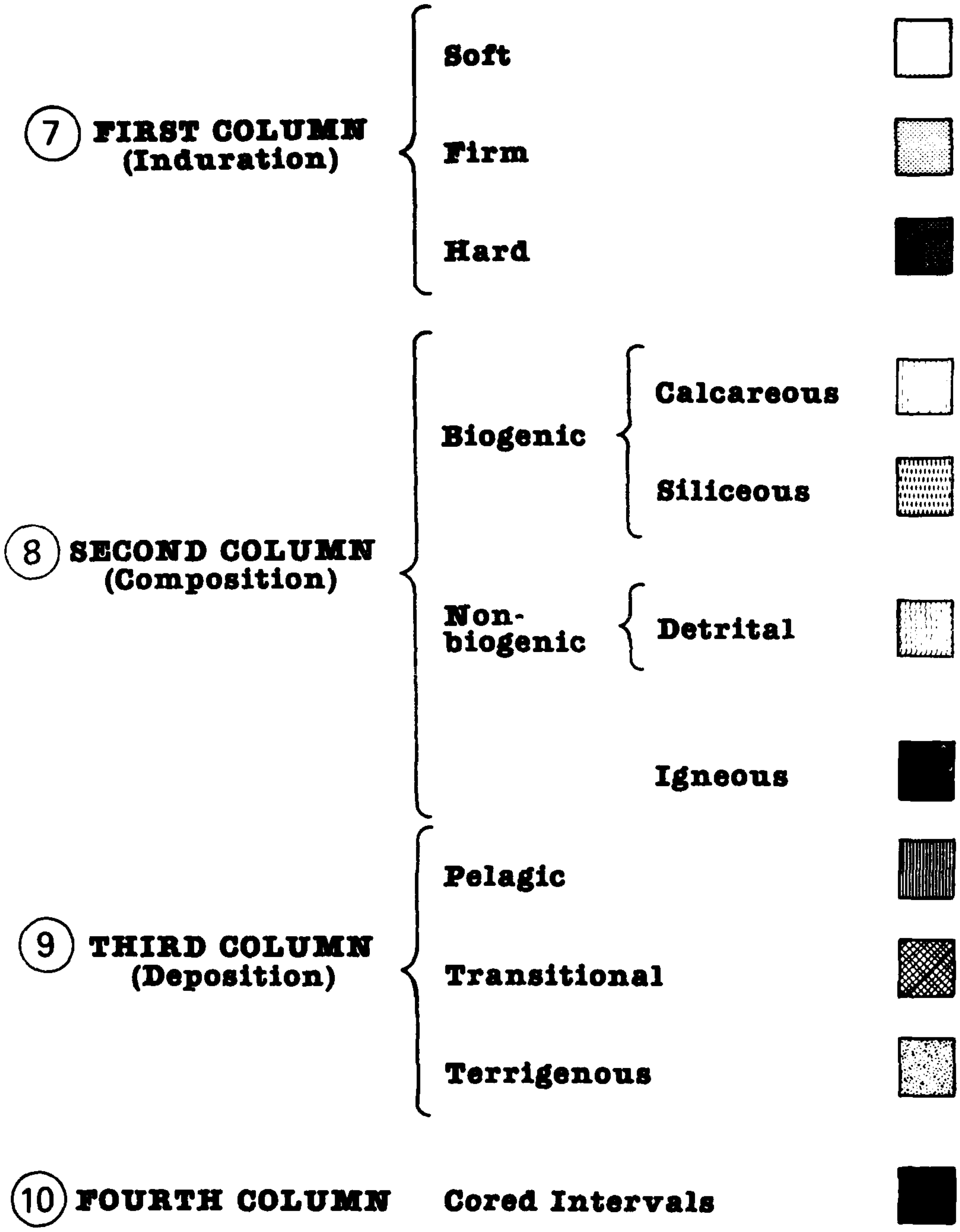


Figure 2. Legend of lithologic data

B. Measurements

The core analysis is divided into two parts: the initial On-Board Studies (Sect. II, B.1) and the subsequent Shore-Based Studies (Sect. II, B.2). The discussion in these sections is predominantly in the form of excerpts quoted from the Initial Reports, and provides the details of measurement relevant to the data plotted in Section V (7, 13-16 of Fig. 1). The Time Stratigraphic scale used is that presented in JOIDES (1974). The abbreviations shown in the Time Stratigraphic Framework Chart in Section II, B.2 are those used in the Data Summary Section.

1. On-Board Studies

a. Porosity, Wet-bulk Density, Water Content*

Aboard the GLOMAR CHALLENGER wet-bulk density and porosity were measured by two methods. One utilized small individual sediment samples, which were collected from the relatively "undisturbed" center portion of the cores. The volumes of these wet samples combined with their wet and dry weights were used to calculate their wet-bulk density and porosity. The second method required measurements of gamma-ray attenuation through the sediments and rocks, which relates to their wet-bulk density. This was done by a system called Gamma Ray Attenuation Porosity Evaluator, which will hereafter be referred to by its acronym GRAPE.

Weight And Volume Density Measurements

Wet-bulk density in this report is defined as the weight in grams of the wet-saturated sediment (or rock) per cubic centimeter of the wet-saturated sediment. Porosity is defined as the volume of pore space divided by the volume of the wet-saturated sample and is expressed as a percentage. Water content is defined as the weight of water in the sediment divided by the weight of the saturated wet-sediment and is also expressed as a percentage. Salt corrections were not made.

Individual soft sediment samples were taken with a one cubic centimeter syringe with the end cut off, squared, and sharpened, so that the leading sharp edge was flush with the inside diameter of the syringe. The sampling technique is similar to that of piston coring. The syringe cylinder and the end of the plunger are placed flush with the surface of the sediment to be sampled, and then the plunger is held stationary while the cylinder is slowly pushed into the sediment. Volume measurements of hard sediments are not possible with this technique.

Volume of the soft sample is measured with the same syringe before the sample is weighed. The sample is then weighed while wet and after drying at 110°C for 24 hours and then cooling in a desicator for at least two hours. The greatest limitation on these measurements is the size of the sample which can be weighed accurately at sea (less than one gram). Therefore, a single weighing, if the sea state permits, has an error of about ± 1 percent, and a single volume measurement on this small sample is subject to a high error of about ± 4 percent. Weight-weight water content measurements, which do not involve volume measurements, have a precision of about ± 2 percent (absolute error).

Calculations of water content, wet-bulk density, and porosity are as follows (without salt correction):

$$\text{Water Content (\%)} = 100 \times \frac{(\text{weight wet sediment}) - (\text{weight dry sediment + salts})}{(\text{weight wet sediment})} \quad (1)$$

*This section, P osity, W bulk, Density and Wate ten is quoted from Boyce (1970).

$$\text{Wet bulk density (g/cc)} = \frac{\text{(Weight wet sediment)}}{\text{(Volume wet sediment)}} \tag{2}$$

$$\text{Porosity (\%)} = (100/1.00\ \text{g/cc}) \left[\frac{\text{(weight wet sediment)} - \text{(weight dry sediment + salts)}}{\text{(Volume wet sediment)}} \right] \tag{3}$$

Averaged, or estimated, grain densities are used when calculating porosity with the shore-based laboratory GRAPE computer program. Some average grain density values are approximated using the porosity, wet-bulk density, and water content measurements done on individual samples by Equation 4. This equation is not precise and has a large scatter of grain densities, especially when the sample has a high porosity, and therefore is used only to get an average value.

$$\text{Porosity} = \frac{\left(\dfrac{\text{wt. water}}{\text{density water}}\right) \times 100}{\left(\dfrac{\text{wt. water}}{\text{density water}}\right) + \left(\dfrac{\text{wt. dry sed. + salt}}{\text{density dry sed. + salt}}\right)}$$

Density Dry Sed. + Salt

$$= \frac{\text{(wt. dry sediment + salt)}}{\left[\dfrac{\text{wt. evaporated water}}{\text{density water}} \dfrac{(100)}{\text{(porosity)}}\right] - \left[\dfrac{\text{wt. evaporated water}}{\text{density water}}\right]} \tag{4}$$

$$= \frac{\text{wt. dry sediment + salt}}{\left[\left(\text{volume evaporated water}\right)\left(\dfrac{100}{\text{porosity}}\right)\right] - \left(\text{volume evaporated water}\right)}$$

Salt correction may be made if desired.

Grape System

Basically, the GRAPE device consists of a drive system to move geologic material between a shielded gamma ray source (Ba^{133}) and a shielded scintillation detector. The system also includes an analog computer which immediately calculates apparent wet-bulk density from the measured parameters. Evans (1965), Harms and Choquette (1965), Evans and Cotteral (1970), Brier et al. (1969), and Whitmarsh (1971) contain discussions of the principle; Evans (1965) and Evans and Cotteral (1970) also give a detailed equipment description.

The GRAPE works on the principle that gamma rays of a specified energy interval (0.3 to 0.359 Mev) are absorbed or scattered when they travel through a sediment or rock sample, and that this attenuation is related to the density of that material. These gamma rays are absorbed or scattered by the electrons in the minerals, and it is assumed that the ratio of the number of electrons in any given mineral to its density can be considered a constant; however, this is not true for all minerals. The variation of this "constant" is seen as a variation of the attenuation coefficient for those "anomalous" minerals. Corrections for these "anomalous" minerals may be applied in the future when the mineralogy and attenuation coefficients become accurately known. At the present, only a correction for the "anomalous" water density, or attenuation coefficient, is applied as it comprises up to 80 percent of the sample..

Theory

The GRAPE system provides continuous apparent wet-bulk density measurements on the basis of gamma ray attenuation in an ideal slab absorber (Evans, 1965):

$$I = I_0 e^{-\mu \rho_B} \tag{5}$$

$$\rho_B = \frac{1}{\mu d} \ln \left(I_0 / I\right) \tag{6}$$

"I is the intensity of the gamma-ray beam which penetrates the absorber with on loss in energy,

I_0 is source intensity,

ρ_B is the bulk density in g/cm^3

is the mass attenuation coefficient in cm^2/g, and

μd is the thickness or diameter of the sample in cm."

In some sediments, it may be necessary to make corrections for minerals whose attenuation coefficients differ significantly ($\pm$ 3%) from that of quartz. Corrections for "anomalous" attenuation coefficients of minerals, other than seawater, were not made, but corrections may be applied in the future when the exact quantitative mineralogy and attenuation coefficient become known.

The above equation with an assumed μ of 0.100 or 0.102 cm^2/g is accurate for minerals which have a similar attenuation coefficient to that of quartz or calcite, respectively, or, in other words, the equation is accurate for minerals that have a ratio of the mineral electron density (ρ_e) to its bulk density (ρ_B) which approximates that of quartz or calcite. According to Evans (1965) "Corrections must be provided when the electron factor (θ) varies significantly ($\pm$ 3% or greater):"

$$\theta = e/B \qquad (7)$$

"A convenient unit for θ is the number of electrons per cubic angstrom (ρ_e) per unit density (ρ_B) ...This ratio is 0.303 for many common rocks and minerals, such as calcite, quartz, dolomite and some clays."

Evans (1965) suggests (and the method followed by Deep Sea Drilling) "In evaluating equation (... Equation 6 above) the most convenient computational procedure is to consider μ a constant, 0.100 cm^2/g, and use corrected grain densities for any sample components having electron factors in the range of 0.294 θ = 0.312 The corrected grain densities (ρ_{GC}) are calculated from the following relationship:

$$GC = \frac{\theta_1 \rho_{GL}}{\theta} \qquad (8)$$

Where θ_1 is the electron factor of the 'abnormal' component, θ is the normal electron factor 0.303, and ρ_{GL} is the measured grain density of the component which requires correction." An example is aluminum which has an electron factor of 0.291 (Evans, 1965).

$$\rho_{GC} = \frac{0.291}{0.303} \times 2.71 \text{ g/cc} = 2.60 \text{ g/cc}$$

Electron density factors and corrected densities of some common minerals are listed in Harms and Choquette (1965), Table 1, P24C-25C) and Evans and Cotteral (1970).

Density values for seawater (1.025 g/cc) and aluminum (2.71 g/cc) are calculated by the GRAPE as approximately 1.125 g/cc and 2.60 g/cc, respectively, when calculations are based on an attenuation coefficient near that of quartz and calcite (0.100 and 0.102 cm^2/g, respectively) (Schlumberger, 1966; Evans, 1965). For an approximation of "true sediment wet-bulk density, similar density corrections for other minerals may be ignored and the GRAPE data thought of as two phases consisting of seawater and solid mineral grains of quartz. Since seawater is a major constituent, a correction factor must be applied. This is accomplished by processing the apparent density data through one of the computer programs described below.

Errors

Whitmarsh (1971) shows a comparison of GRAPE density averages per 1.5 meter core lengths (referred to as sections) to wet-bulk densities determined by weight and volume measurements of the entire 1.5 meter core section. These section-density averages agreed within $\pm$0.03 g/cc, which is very good when considering the variables. The GRAPE samples a pencil size area across the diameter of the core including a disturbed portion of the sides of the liner, which is about 12 percent of the sample. However, that same disturbed sediment around the outer perimeter is a large volume of the core and is about

25 percent of the entire volume of the core section used in the weight-volume density calculations. In addition, minerals may be present which have a different attenuation coefficient than that of calcite.

In general, wet-bulk density data of small weighed samples agree with the GRAPE data within ±5 percent. This is fairly good when considering that the actual samples of the two methods are different. The individual porosity and wet-bulk density weighed samples are small (less than 1 cc) and from the center portion of the cores, while the GRAPE samples are of pencil size volume and extend across the entire diameter of the core. This includes the outer peripheries of the cores which are usually disturbed as a soup or heavy paste. In addition, the single GRAPE sample is a moving average of about 1 cm which is measured in a time of 2 seconds (actual movement is 2.95 mm). This short 2 second gamma ray counting period by itself has an error of ±6 percent.

b. Sound Velocity*

Sound velocity measurements were taken in each major lithology on undisturbed samples. From some high quality hand-sized samples it is possible to detect anisotrophy. Samples of stiff sediment or isolated chunks of hard rock are lifted from the core and cleaned of disturbed material. The surfaces of the sample that have contact with the transducers are carefully (so as not to disturb the sample) squared off with a knife or saw and smoothed. The acoustical contact with the transducers is made with a few drops of seawater.

In a few instances, the velocities of weak sediments were measured through the core liner when the sediments were too soft to be handled without destroying their integrity. In these measurements, the typical liner travel time and liner thickness, as measured with the transducers, were subtracted in the calculation. These measurements were used to get a "ball park" answer for a particular sediment type, or for drilling predictions; these data are discussed as generalities in the text and labeled in the tables as approximate data.

When samples contained abundant gas it was not possible to measure velocities because of sound pulse attenuation. Even if the pulse were not completely attenuated, the data would not be representative of in situ conditions, despite pressure and temperature corrections because of gas expansion and loss factors.

Sound Velocity Method and Equipment for the Hamilton Frame System

Sound velocity is essentially the distance that sound waves travel at a given temperature and pressure. To effectively assess the sound velocity of rocks or sediments we must measure the distance the sound wave travels, the time required to travel this distance, and the temperature and pressure at which this occurs. In this case, it is the compressional velocity at 400 kHz.

In the Hamilton-Frame system, the travel distance is measured simply by attaching a Dial Micrometer to a transducer that moves a vertical distance equal to the sample thickness. When the sending and receiving transducers are touching each other, there is zero distance between them. A distance reading D_1 is recorded from the Dial Micrometer. When a sample is placed between the transducers, a second Dial Micrometer reading D_2 is recorded, and the travel distance is calculated as D_1-D_2.

The travel time across the sample is measured in a similar manner as the distance and is made simultaneously with the distance measurements. The lower transducer sends the sound wave

*Sound Velocity section quoted from Boyce (1970)

and the upper one receives it. When the two transducers are together, the received wave is observed in an oscilloscope and a relative time reading, t_1, is recorded. There is some relative time across the transducers at zero separation. A sample is placed between the transducers and a second reading, t_2, of the received wave is recorded. This is essentially the relative time the sound takes to cross the transducers plus the sample. Thus, the time that the sound traveled through the sample is t_2-t_1. Velocity is calculated by $Vp = (D_1-D_2/t_2-t_1) =$ km/sec. The temperature of the sample is recorded at the time of measurement.

Temperature

The velocity measurements were done after the samples were brought to room temperature. This allows for a good comparison of data and eliminated samples with a temperature gradient. The temperatures of the soft sediments could be obtained by simply inserting a thermometer into, or near the sample. Where the rocks were without a soft matrix in which to insert a thermometer, the room temperature was recorded after sufficient time was allowed for the rock to come to room temperature.

Sound Velocity Test And Comparisons

1. Distilled water at a known temperature

Measured	Theoretical	Percent Error
1.503	1.489	+0.93
1.490	1.489	+0.07
1.486	1.490	-0.27

2. Semistandard lucite, brass and aluminum blocks.

	LUCITE	BRASS	ALUMINUM
Boyce	2.741 km/sec	4.506 km/sec	6.293 km/sec
Leg 15	(±0.84%)	(±0.45%)	(±1.29%)
Schrieber[3]	2.745 km/sec	4.529 km/sec	6.295 km/sec
	(±0.006 km/sec	(±0.004 km/sec	(±0.008 km/sec

c. Penetrometer*

The purpose of the penetration measurements is to indicate relative differences of the sediment stiffness for purposes of lithologic description. Penetrometer values are in units of millimeters that a standard needle will penetrate under a fixed load of 50 g ± .1 g. The standard needle is about 5 cm in length and 1.00 to 1.02 mm in diameter. This equipment is described in detail in American Society of Testing and Materials (1965). These measurements are not designed to be a calculated specific unit of strength such as shear strength. Because the surface sediments are normally disturbed during coring operations, these values are not necessarily representative of in situ conditions.

d. Seismic Profiles

All the photographs in this report are of seismic reflection data collected on the R/V GLOMAR CHALLENGER. The seismic reflection profiler system was generally the same on all legs, consisting of:

1. Bolt PAR 600A airgun of variable size, 30-300 cubic inches.
2. A 20-element EVP23 towed array.
3. Bolt FA-7 band pass filter, set for a 30-150 Hz band.
4. Two EDO Western Model PBR 333 recorders.

Sites with seismic record photographs missing indicate no adequate data are available on microfilm from the GLOMAR CHALLENGER. Other research vessels gathered seismic data on the preliminary site surveys and generally, have data available. To find other sources for seismic data, refer to the Initial Reports of the Deep Sea Drilling Project.

*Penetrometer explanation comes from Boyce, (1970).

2. Shore-based Studies

a. Grain-Size Analyses

Grain-Size distribution was determined by standard sieving and pipette analysis. The sediment sample was dried and then dispersed in a Calgon solution. If the sediment failed to disaggregate in Calgon, it was dispersed in hydrogen peroxide. The sand-sized fraction was separated by a 62.5 μm sieve, with the fines being processed by standard pipette analysis following Stokes settling velocity equation, which is discussed in detail in Volume IX of the Initial Reports of the Deep Sea Drilling Project. Step-by-step procedures are covered in Volume IV. In general, the sand-, silt-, and clay-sized fractions are reproducible within $\pm 2.5\%$ (absolute) with multiple operators over a long period of time. A discussion of this precision is in Volume IX. Sediment classification is after Shepard (1954) or JOIDES (1974) with the sand, silt, and clay size boundaries based on the Wentworth (1922) scale (Figs. 3a & 3b Lithologic Data, this paper).

b. Carbon and Carbonate Analyses*

The carbon-carbonate data were determined by a Leco induction furnace combined with a Leco acid-base semi-automatic carbon determinator. Normally, the more precise seventy-second analyzer is used in place of the semi-automatic carbon determinator.

The sample was burned at 1600°C, and the liberated gas of carbon dioxide and oxygen was volumetrically measured in a solution of dilute sulfuric acid and methyl red. This gas was then passed through a potassium hydroxide solution, which preferentially absorbs carbon dioxide, and the volume of the gas was measured a second time. The volume of carbon dioxide gas is the difference of the two volumetric measurements. Corrections were made to standard temperature and pressure. Step-by-step procedures are in Volume IV of the Initial Reports of the Deep Sea Drilling Project and a discussion of the method, calibration, and precision are in Volume IX.

Total carbon and organic carbon (carbon remaining after treatment with hydrochloric acid) are determined in terms of percent by weight and the theoretical percentage of calcium carbonate is calculated from the following relationship:

Percent calcium carbonate ($CaCO_3$) = (%total C -%C after acidification) X 8.33

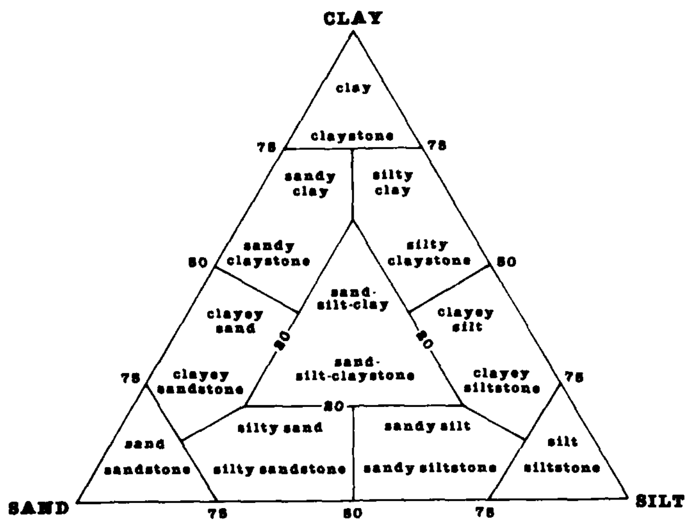
However, carbonate sediments may also include magnesium, iron, or other carbonate; this may result in "calcium" carbonate values greater than the actual content of calcium carbonate. In our determinations, all carbonate is assumed to be calcium carbonate. Precision of the determination is as follows:

Total carbon (within 1.2%-12%	=	$\pm$0.3% absolute
Total carbon (within 0%-1.2%	=	$\pm$0.06% absolute
Organic carbon	=	$\pm$0.06% absolute
Calcium carbonate (within 10% -100%)	=	$\pm$3% absolute
(within 0% - 10%)	=	$\pm$1% absolute

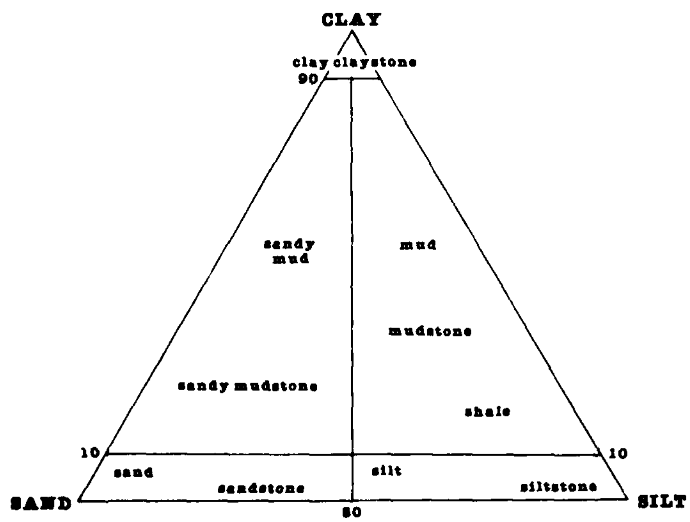
c. Silica Analysis

The silica percentage was taken from a smear slide description of a portion of the sediment or rock. A thin layer of material is applied with water onto a glass slide. It is first dried, then covered with a material of known refractive index. The material is then observed with a transmitted-light microscope. The optical behavior of a mineral allows its composition to be determined and its relative abundance is estimated. It is assumed that,

*Carbon and Carbonate Analyses sections summarized and quoted from Boyce and Bode (1972).



(after Sheppard 1954)



(JOIDES 1974)

Figure 3. Sediment textural classifications

within a reasonable error range, the scientists are consistent in determining what minerals are on a slide and what their relative abundances are.

d. X-ray Methods

Samples of sediment were examined using X-ray diffraction methods at the University of California under the supervision of H. E. Cook

Treatment of the raw samples included washing to remove seawater salts, grinding to less than 10 μm under butanol, and expansion of montmorillonite with trihexylamine acetate. The sediments were X-rayed as randomized powders. A more complete account of the methods used at Riverside is found in Appendix III of Volume IV and Appendix III of Volume XXVIII of the Initial Reports.

e. Time Stratigraphic Framework

Abbreviations of geologic time units used are shown in Figure 4, along with the classification scheme recommended by the JOIDES Advisory Panel on Paleontology and Biostratigraphy in Appendix I, Vol. 3, pp. 609, Initial Reports of the Deep Sea Drilling Project.

C. Lithologic Classification

Two lithologic classifications are discussed in this section. The first classification scheme (Sect. II, C.1) was devised for use with digital computers (Davies et al., 1977). This automated scheme was used to generate the lithologic presentations in the Data Summary Section of this report, and is used by the DSDP with their automated data files. The second classification (Sect. II, C.2) is a more complete and formal scheme which is used in the Initial Reports, JOIDES (1974). Both schemes are discussed here to enable the reader to discern their similarities and dissimilarities, and to compare the condensed data presentation of this report to be more complete lithologic classifications of the Initial Reports.

1. Automated Lithologic Classification Scheme

The lithologic classification scheme used in this study is taken from a computer program developed by Davies, Mushich, and Woodbury (1977) for the automated classification of deep-sea sediments. They utilized a modification of a deep-sea sediment classification scheme developed by a working group from the JOIDES Advisory Panel on Sedimentary Petrology and Physical Properties (see Section I. A.2.), which has been used by DSDP since Leg 38.

The modified scheme is a dichotomous key (Fig. 5) with which sediments are initially separated into those that are dominantly biogenetic in composition and those that are not. Biogenetic sediments are defined as those in which either the siliceous or calcareous fossil content exceeds 30% or in which the total biogenetic components exceed 50%. Biogenetic sediments in which the total biogenetic component exeeds 70% are considered pure biogenetic sediments; those with less than 70% are considered transitional biogenetic sediments. The classification divides the biogenetic sediments into those which are primarily calcareous and those which are siliceous. Both pure and transitional biogenetic sediments are then further subdivided into monogenetic and heterogeneous groups, and are finally classified on the basis of the major biogenetic component. Monogenetic calcareous sediments have more than 60% carbonate, and monogenetic siliceous sediments more than 50% siliceous fossils. Dolomites (greater than 70% dolomites) and shallow-water carbonates (greater than 30% shallow-water indicators) are separated as special groups.

The nonbiogenetic (detrital) sediments are divided, on the basis of the presence or absence of more than 10% "slow-sediment indicators," into pelagic and nonpelagic (terrigenous) groups. Slow sediment indicators include authigenic components (zeolites, iron manganese micronodules,

APPROX. TIME (10^6 YEARS)	ERA	PERIOD	SERIES	STAGE
	CENOZOIC CEN	QUAT. QUAT	Holocene HOLO	
	CENOZOIC CEN	QUAT. QUAT	Pleistocene PLEIS	
1.5	CENOZOIC CEN	TERTIARY TERT	Pliocene PLI	upper uPLI
	CENOZOIC CEN	TERTIARY TERT	Pliocene PLI	lower lPLI
7	CENOZOIC CEN	TERTIARY TERT	Miocene MIO	upper uMIO
	CENOZOIC CEN	TERTIARY TERT	Miocene MIO	middle mMIO
	CENOZOIC CEN	TERTIARY TERT	Miocene MIO	lower lMIO
26	CENOZOIC CEN	TERTIARY TERT	Oligocene OLI	upper uOLI
	CENOZOIC CEN	TERTIARY TERT	Oligocene OLI	middle mOLI
	CENOZOIC CEN	TERTIARY TERT	Oligocene OLI	lower lOLI
37-38	CENOZOIC CEN	TERTIARY TERT	Eocene EOC	upper uEOC
	CENOZOIC CEN	TERTIARY TERT	Eocene EOC	middle mEOC
	CENOZOIC CEN	TERTIARY TERT	Eocene EOC	lower lEOC
53-54	CENOZOIC CEN	TERTIARY TERT	Paleocene PAL	upper uPAL
	CENOZOIC CEN	TERTIARY TERT	Paleocene PAL	lower lPAL
64-65	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Meastrichtian MAES
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Campian CAMP
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Santonian SANT
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Coniacian CONI
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Turonian TURO
	MESOZOIC MES	CRETACEOUS CRET	upper uCRET	Cenomanian CENO
100	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Albian ALBI
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Aptian APTI
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Barremian BARR
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Hauterivian HAUT
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Valangianian VALA
	MESOZOIC MES	CRETACEOUS CRET	lower lCRET	Berriasian BERR
136	MESOZOIC MES	JURASSIC JURA	upper uJURA	Tithonian TITH
	MESOZOIC MES	JURASSIC JURA	upper uJURA	Kimmeridgian KIMM
	MESOZOIC MES	JURASSIC JURA	upper uJURA	Oxfordian OXFO
154				

Figure 4. Time stratigraphic framework

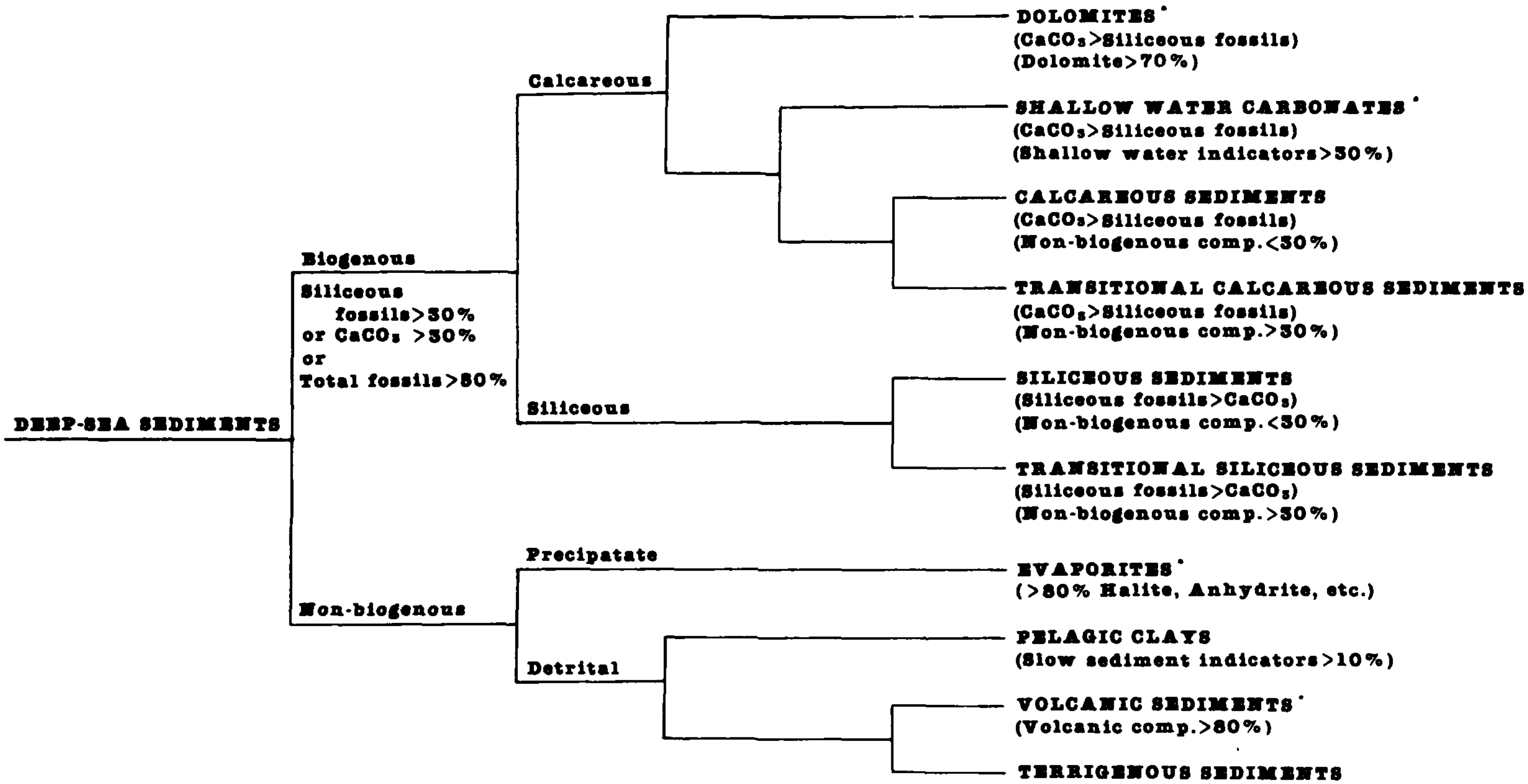


Figure 5. Scheme used for automated classification of deep-sea sediments

etc.), fish debris, and other indicators of very slow accumulation rates. Non-slow indicator sediments are divided into terrigeneous and volcanogenic (greater than 80% volcanogenic material) sediments classified on the basis of texture using schemes proposed by Wentworth (1922) and Wentworth and Williams (1932), as shown in Figures 3a and 3b. All sediment groups are classified according to the degree of induration.

2. JOIDES Lithologic Classification Scheme*

PRINCIPLES USED IN CLASSIFICATION

1. This is a lithologic summary classification designed to generalize core descriptive material of greater detail into a form suitable for standard core and hole logs. Its systematic use will facilitate core to core and leg to leg comparisons.

2. The classification covers most of the lithologic types encountered so far but does not attempt to be comprehensive. A category "special Rock Types" allows additional definitions and terminology at the discretion of the shipboard staff for rock types not covered.

3. Sediment names are those in common usage and have been defined within the limits of existing definitions.

4. Categories are based on sediment parameters measured on board ship. Refinement by shore laboratory data is possible but not necessary.

5. The classification is descriptive and genetic implications are not intended.

6. The degree of detail of the classification is scaled to the space limitations of printed graphic hole and core summaries.

*Explanation of JOIDES Lithologic Classification Scheme quoted from JOIDES (1974)

SHIPBOARD PARAMETERS MEASURED

Sediment and rock names are defined solely on the basis of compositional and textural parameters. The compositional factors are most important for description of those deposits more characteristic of open marine conditions, with textural factors becoming more important for the classification of hemipelagic and near-shore facies. Sediment names are thus based solely upon these parameters as determined in smear slides aided by compositional and textural properties apparent to the naked eye or under the hand lens. Other descriptive parameters include: induration, sediment disturbance, sedimentary structures, and color. The determination of these parameters is as follows:

1) Composition - biogenic and mineral components are estimated in percent from smear slides. $CaCO_3$ content is estimated by using the carbonate bomb available on the ship. Even with rapid use, a value of $\pm 5\%$ is achievable.

2) Texture - visual estimates from smear slide examination.

3) Induration - The determination of induration is highly subjective, but field geologists have successfully made similar distinctions for many years. The categories suggested here are thought to be practical and significant. The criteria of Moberly and Heath (1971) are used for calcareous deposits; subjective estimate or behavior in core cutting for others. There are three classes for calcareous sediments: two for all others.

a) Calcareous sediments

(i) Soft: Oozes have little strength and are readily deformed under the finger or the broad blade of a spatula.

(ii) Firm: Chalks are partly indurated oozes; they are friable limestones that

are readily deformed under the fingernail or the edge of a spatula blade. More indurated chalks are termed limestones (see below).

(iii) Hard: Limestones as a term should be restricted to cemented rocks.

b) The following criteria are recommended for all but calcareous sediments:

(i) If the material is low state of induration as to allow the core to be split with a wire cutter, the sediment name only is used (e.g., silty clay; mud).

(ii) If the core must be cut on the band saw or diamond saw, the suffix 'stone' is used (e.g., silty claystone; mudstone, or shale, if fissile).

4) Sediment Disturbance - Deformation structures are generally of the type found in piston cores, and are usually simple to visualize and interpret.

a) Soft to firm sediment: The following categories are recommended.

(i) Slightly deformed-bedding contacts are slightly bent.

(ii) Moderately deformed-bedding contacts have undergone extreme bowing.

(iii) Very deformed-bedding is completely disturbed, sometimes showing symmetrical diapir-like structure.

(iv) Soupy-water saturated intervals which have lost all aspects of original bedding.

b) Hard sediments: There is also the need to indicate the degree of fracturing in hard sediments/rock. This is best accomplished with a written description in the Lithologic Description portion of the Core Form (Fig. 6).

5) Sedimentary structures - In many cores it is extremely difficult to differentiate between natural and coring-induced structures. Consequently, the description of sedimentary structures is optional. The following approach is suggested as a guideline, but the specialist is encouraged to use his own preferred system and set of symbols.

a) Median grain size profile: For the sections of terrigenous sediments, with interbeds of varying textural characteristics, the construction of median grain size profile based on hand lens observations provides a rapid method for illustrating graded and non-graded beds, bed thicknesses, and size distribution.

b) Sedimentary structures: A set of suggested symbols is provided for categories shown on (Fig. 7).

6) Color - According to standard Munsell and GSA color charts.

USE OF THE CORE FORM

1) Mandatory Graphic Lithology Column - This graphic column is based on the above classification scheme. Completion of the column using the appropriate symbols (Fig. 8) must be done for each site, and will be included in the Initial Core Description (ICD) and Initial Report Volume. The "Special Rock Type" category should be used for sediment types not in the classification.

a) Optional graphic column: If circumstances or the special skills and interests of the shipboard staff indicate an additional modified or different classification, another graphic column may be added to the right of the Mandatory Column using definitions, terminology and symbols that, in the opinion of the shipboard staff, will increase the information yield. This Optional Column must not substitute for the Mandatory Column.

2) Sediment disturbance column - Completion of the sediment disturbance column using symbols and distinctions given below is mandatory.

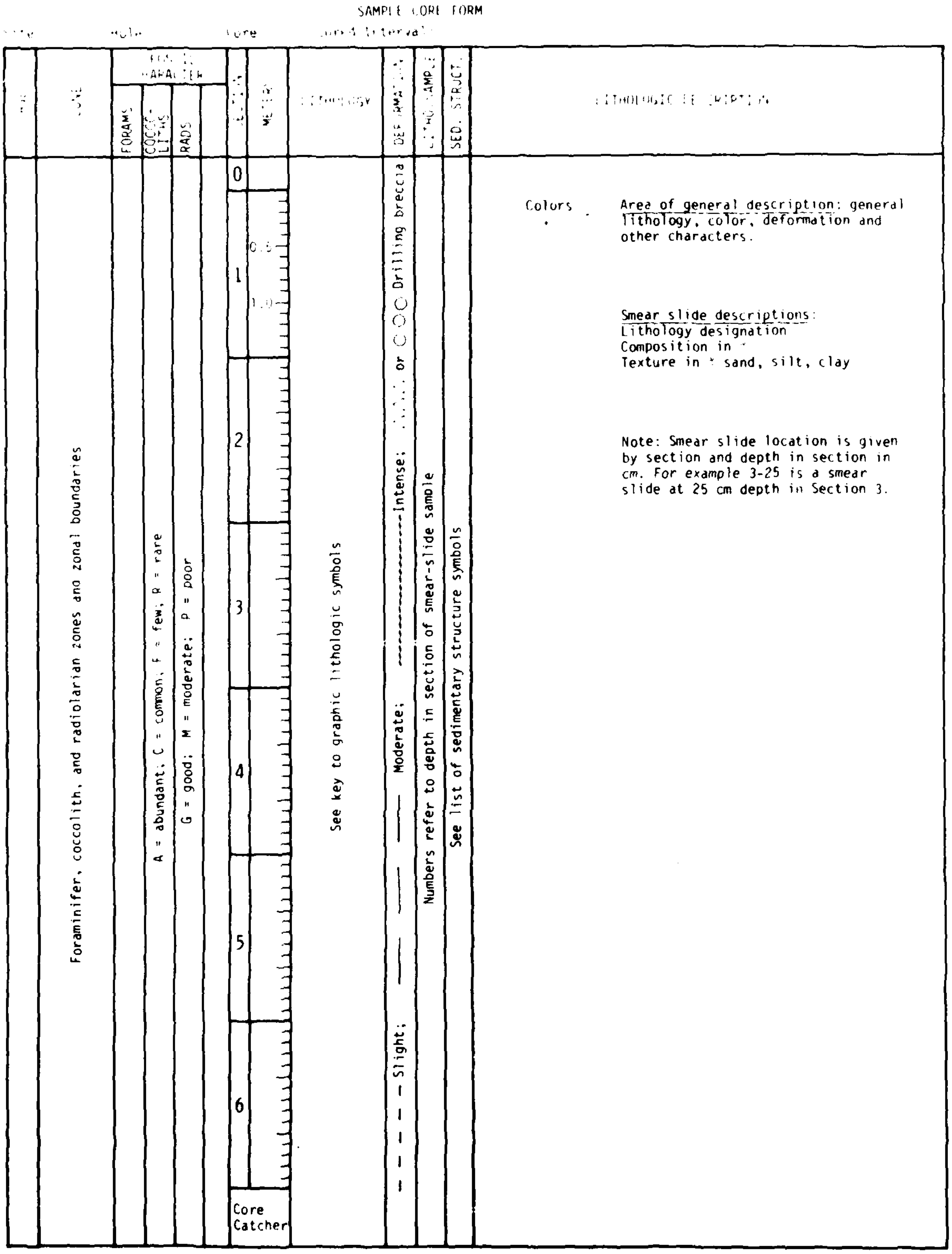


Figure 6. Sample core form (from DSDP, Vol. 39)

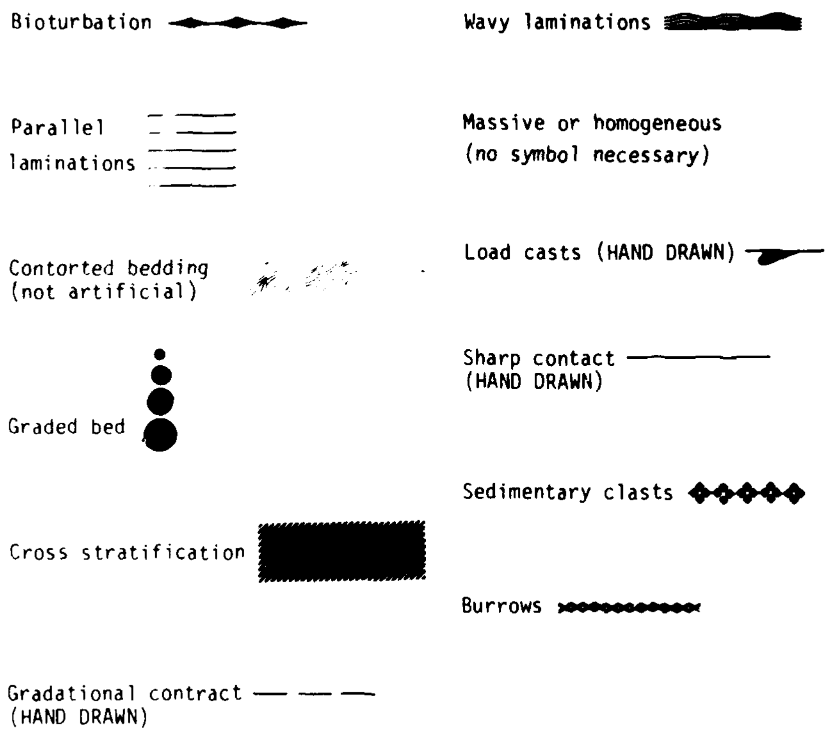


Figure 7. Sedimentary structure symbols (from DSDP, Vol. 39)

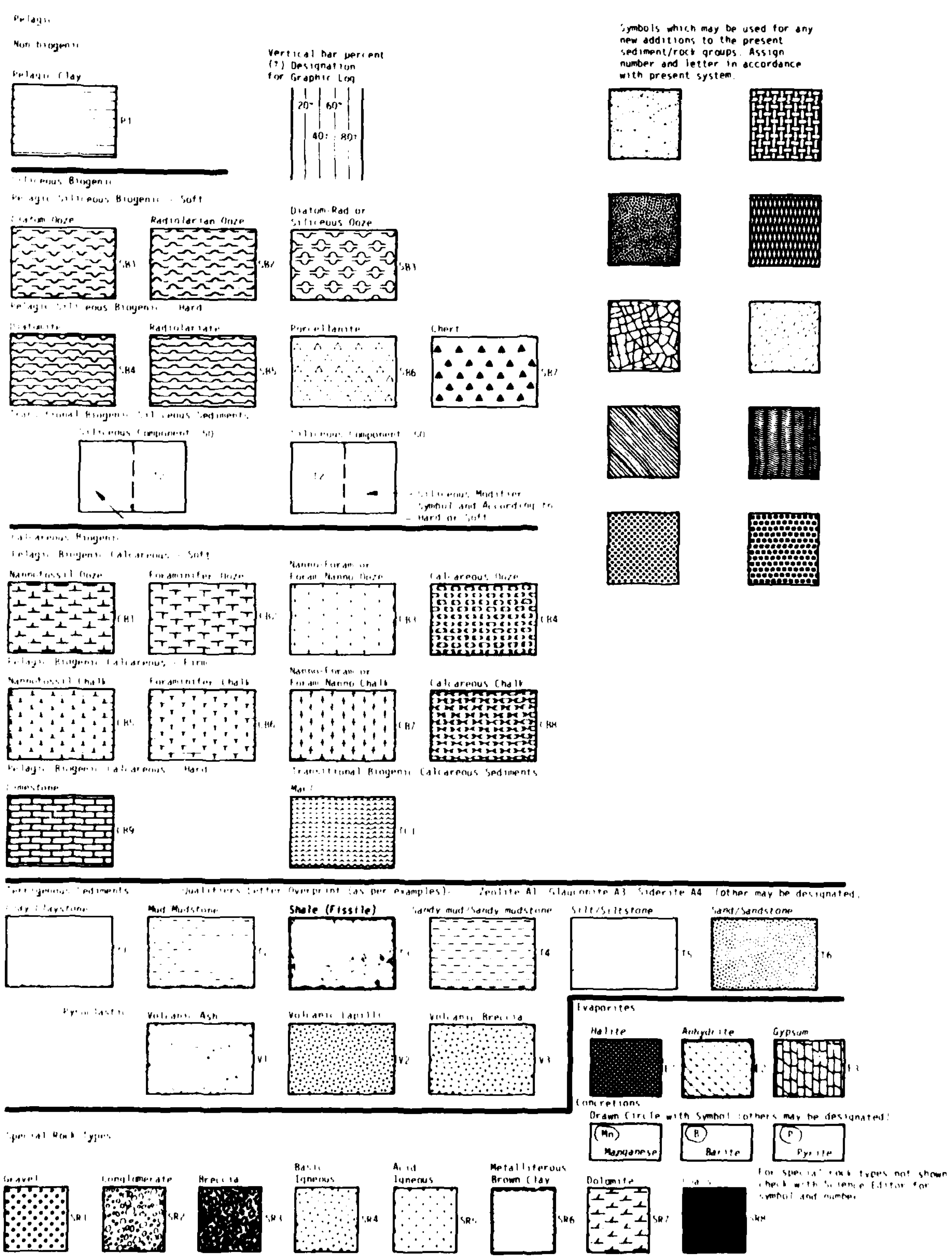


Figure 8. Lithologic symbols (from DSDP, Vol. 39)

3) Sedimentary structure columns - Structures may be designated on the core form in the sedimentary structure column parallel to the sediment disturbance column, and/or on the median grain size profile (for the sections of terrigenous sediments, with interbeds of varying textural characteristics). The median grain size profile is located in the lithologic description portion of the core form. A set of suggested symbols for a few more common structures has been prepared by DSDP (Fig. 6), but the shipboard geologist is free to use whatever additional symbols he may wish. These optional columns may not substitute for the mandatory sediment disturbance column and must be distinct from it.

4. Lithologic description column - Format, style, and terminology of the descriptive portion of the core sheets are not controlled by the mandatory column scheme, beyond the minimal name assignment which should be derived from this classification. However, colors and additional information on structure and textures should normally be included in the textural section of the core description.

LITHOLOGIC CLASSIFICATION SCHEME

The following define compositional class boundaries and use of qualifiers in the lithologic classification scheme:

1) Compositional Class Boundaries

a) $CaCO_3$ content (determined by $CaCO_3$ bomb): 30% and 60%. With a 5% precision and given the natural frequency distribution of $CaCO_3$ contents in oceanic sediments, these boundaries can be reasonably ascertained.

b) Biogenic opal abundance (expressed as percent siliceous skeletal remains in smear slides): 10%, 30%, and 50%. Smear-slide estimates of identifiable siliceous skeletal material generally imply a significantly higher total opal abundance. The boundaries have been set to take this into account.

c) Abundance of authigenic components (zeolites, Fe, and Mn microndules etc), fish bones, and other indicators of very slow sedimentation (estimated in smear slides); semi-quantitative boundary: common 10%. These components are quite conspicuous and a semi-quantitative estimate is adequate. Even a minor influx of calcareous, siliceous, or terrigenous material will, because of the large difference in sedimentation rate, dilute them to insignificance.

d) Abundance of terrigenous detrital material (estimated from smear slides): 30%.

e) Qualifiers: Numerous qualifiers are suggested; the options should be used freely. However, components of less than 5% (in smear slide) should not be used as a qualifier except in special cases. The most important component should be the last qualifier. No more than two qualifiers should be used.

Description of Sediment Types

1) Pelagic clay - Principally authigenic pelagic deposits that accumulate at very slow rates. The class is often termed brown clay, or red clay, but since these terms are confusing, they are not recommended.

a) Boundary with terrigenous sediments: Where authigenic components (Fe/Mn micronodules, zeolites), fish debris, etc., become common in smear slides. NOTE: Because of large discrepancy in accumulation rates, transitional deposits are exceptional.

b) Boundary with siliceous biogenic sediments: <30% indentifiable siliceous remains.

c) Boundary with calcareous biogenous sediments: Generally the sequence is one passing from pelagic clay through siliceous ooze to calcareous ooze, with one important exception: at the base of

many oceanic sections, black, brown or red clays occur directly on basalt, overlain by or grading up into calcareous sediments. Most of the basal clayey sediments are rich in iron, manganese and metallic trace elements. For proper identification they require more elaborate geochemical work than is available on board. These sediments are placed in the "Special Rock" category, but care should be taken to distinguish them from ordinary pelagic clays.

2) Pelagic siliceous biogenic sediments - These are distinguished from the previous category because they have more than 30% identifiable siliceous microfossils. They are distinguished from the following category by a $CaCO_3$ content of less than 30%. There are two classes: Pelagic biogenic siliceous sediments (containing less than 30% silt and clay); and transitional biogenic siliceous sediments (containing more than 30% silt and clay and more than 10% diatoms).

a) Pelagic biogenic siliceous sediments:

soft: siliceous ooze (radiolarian ooze, diatom ooze, depending on dominant component).

hard:	radiolarite	porcellanite
	diatomite	chert

(i) Qualifiers:

Radiolarians dominant: radiolarian ooze or radiolarite.

Diatoms dominant: diatom ooze or diatomite. Where uncertain: siliceous (biogenic) ooze, or chert or porcellanite, when containing >10% $CaCO_3$, qualifiers are as follows:

indeterminate carbonate:	calcareous --
nannofossils only:	nannofossil --
foraminifers only:	foraminifer --

or

nannofossil-foraminifer -- depending on dominant component
foraminiferal-nannofossil --

b) Transitional biogenic siliceous sediments:

Diatoms <50%	diatomaceous mud:	soft
	diatomaceous mudstone:	hard
Diatoms >50%	muddy diatom ooze:	soft
	muddy diatomite:	hard

Radiolarian equivalents in this category are rare and can be specifically described.

3) Pelagic biogenous calcareous sediments - These are distinguished from the previous categories by a $CaCO_3$ content in excess of 30%. There are two classes: Pelagic biogenic calcareous sediments (containing less than 30% silt and clay); and transitional biogenic calcareous sediments (containing more than 30% silt and clay).

a) Pelagic biogenic calcareous sediments:
soft: calcareous ooze
firm: chalk
hard: indurated chalk.

The term limestone should preferably be restricted to cemented rocks.

(i) Compositional Qualifiers - Principal components are: nannofossils and foraminifers. One or two qualifiers may be used, for example:

Foram %	Name
<10	Nannofossil ooze, chalk, limestone.
10-25	Foraminiferal-nannofossil ooze
25-50	Nannofossil-foraminifer ooze
>50 for:	Foraminifer ooze

Calcareous sediment containing more than 10%-20% identifiable siliceous fossils carry qualifier radiolarian, diatomaceous, or siliceous depending on

the quality of the identification. For example, radiolarian-foraminifer ooze.

b) Transitional biogenic calcareous sediments

(i) $CaCO_3$ = 30%-60%: marly calcareous pelagic sediments.
soft: marly calcareous (or nannofossil, foraminifer, etc.), ooze (see below)
firm: marly chalk
hard: marly limestone

(ii) $CaCO_3$ >60%: Calcareous pelagic sediments.

soft: calcareous (or nannofossil, foraminifer, etc.), ooze (see below)
firm: chalk
hard: limestome

NOTE: Sediments containing 10%-30% $CaCO_3$ fall in other classes where they are denoted with the adjective "calcareous." Less than 10% $CaCO_3$ is ignored.

4) Terrigenous sediments

a) Sediments falling in this portion of the classification scheme are subdivided into textural groups on the basis of the relative proportions of three grain size constituents, i.e., clay, silt, and sand. Rocks coarser than sand size are treated as "Special Rock Types." The size limits for these constituents are those defined by Wentworth (1922) (Fig. 9).

Five major textural groups are recognized on the accompanying triangular diagram (Fig. 3). These groups are defined according to the abundance of clay (>90%, 90-10%, <10%) and the ratio of sand to silt (>1 or <1). The terms clay, mud, sandy mud, silt, and sand are used for the soft or unconsolidated sediments which are cut with a wire in the shipboard core splitting process. The hard or unconsolidated equivalents for the same textural groups are claystone, mudstone (or shale, if fissile), sandy mudstone, siltstone, and sandstone. Sedimentary rocks falling into the consolidated category include those which must generally be cut with the band saw or diamond saw. Sands and sandstones may be subdivided further into very fine-, fine-, medium-, coarse-, or very coarse-grained sands and sandstones according to their median grain size.

(i) Qualifiers - In this group numerous qualifiers are possible, usually based on minor constituents, for example: glauconitic, pyritic, feldspathic. In the sand and sandstone category, conventional divisions such as arkose, graywacke, etc., are of course, acceptable, providing the scheme is properly identified. Clays, muds, silts, and sands containing 10%-30% $CaCO_3$ shall be called calcareous.

b) Volcanogenic sediments

Pyroclastic rocks are described according to the textural and compositional scheme of Wentworth and Williams (1932). The textural groups are:

Volcanic breccia >32 mm
Volcanic lapilli <32 mm
Volcanic ash (tuff, if indurated) <4 mm
Compositionally, these pyroclastic rocks are described as vitric (glass), crystal or lithic.

c) Clastic sediments of volcanic provenance are described in the same fashion as the terrigenous sediments, noting the dominant composition of the volcanic grains where possible.

5) Special rock types - The definition and nomenclature of sediment and rock types not included in the system described above are left to the discretion of shipboard scientists with the recommendation that they adhere as closely as practical to conventional terminology.

In this category fall such rocks as:
Intrusive and extrusive igneous rocks;
Evaporites, halite, anhydrite, gypsum (as a rock), etc.;
Shallow water limestone (biostromal, biohermal, coquina, oolite, etc.);

	Millimeters		Phi (φ) units	Wentworth size class
	2.00	2	1.0	Granule
	1.68		0.75	
	1.41		0.5	Very coarse sand
	1.19		0.25	
	1.00	1	0.0	
	0.84		0.25	
	0.71		0.5	Coarse sand
	0.59		0.75	
SAND	0.50	1/2	1.0	
SAND	0.42		1.25	
SAND	0.35		1.5	Medium sand
SAND	0.30		1.75	
SAND	0.25	1/4	2.0	
	0.210		2.25	
	0.177		2.5	Fine sand
	0.149		2.75	
	0.125	1/8	3.0	
	0.105		3.25	
	0.088		3.5	Very fine sand
	0.074		3.75	
	0.0625	1 6	4.0	
	0.053		4.25	
SILT	0.044		4.5	Coarse silt
SILT	0.037		4.75	
SILT	0.031	1/32	5.0	
	0.0156	1/64	6.0	Medium silt
	0.0078	1/128	7.0	Fine silt
	0.0039	1/256	8.0	Very fine silt
	0.0020		9.0	
MUD	0.00098		10.0	Clay
MUD	0.00049		11.0	
MUD	0.00024		12.0	
	0.00012		13.0	
	0.00006		14.0	

Grade scales for terrigenous sediment.

Figure 9. Sediment grain size scale

Dolomite;
Gravels, conglomerates, breccias;
Metalliferous brown clays;
Concretions, barite, iron-manganese, phosphite, pyrite, etc.;
Coal, asphalt, etc.;
and many others.

The mandatory graphic lithology column should be completed by shipboard staff with appropriate symbols for intervals containing special rock types. It is imperative that symbols and rock nomenclature be properly defined and described by shipboard staff.

III. Selected Bibliography of Special Studies

Included in the Initial Reports, along with the site discussions, are a number of "Special Studies". These studies are generally directed toward selected sites or synthesize the drill sites of a single leg; however, they often have regional or global significance. This section is comprised of a list of papers which appear in the Special Studies section of the Initial Reports, Volumes 1-44, which deal with geophysical, engineering, and physical properties of the sea floor.

Comparison of Three Methods of Measuring or Estimating Sonic Velocity in Sediments, Dean A. McManus, Vol. V, Chap. 27, p. 545, 1969.

Saturated Bulk Density, Grain Density and Porosity of Sediment Cores from the Western Equatorial Pacific: Leg 7, GLOMAR CHALLENGER, E. L. Gealy, Vol. VII, pt. 2, Chap. 24, p. 1081, 1969.

Sound Velocity, Elastic Constants, and Related Properties of Marine Sediments in the Western Equatorial Pacific: Leg 7, GLOMAR CHALLENGER, E. L. Gealy, Vol. VII, pt. 2, Chap. 25, p. 1105, 1969.

Physical Properties Synthesis, F. M. Cook and H. E. Cook, Vol. IX, pt. 3, Chap. 23, p. 945, 1969.

Leg XI Measurements of Physical Properties in Sediments of the Western North Atlantic and their Relationship to Sediment Consolidation, Fred J. Paulus, Vol. XI, pt. 3, Chap. 24, p. 667, 1970.

Compressional Sound Velocities in Semi-Indurated Sediments and Basalts from DSDP Leg XI, Edward Schreiber, P. J. Fox, and J. Peterson, Vol. XI, pt. 3, Chap. 25, p. 723, 1970.

Discussion and Interpretation of Some Physical Properties, R. B. Whitmarsh, Vol. XII, pt. 2, Chap. 12, p. 935, 1970.

Underway Geophysical Measurements Obtained on the GlOMAR CHALLENGER in the Eastern North Atlantic and Mediterranean Sea, W. B. F. Ryan and T. B. Gustafson, Vol. XIII, pt. 2, Chap. 15, p. 517, 1970.

Geophysical Surveys at Sites 120, 121, and 132 of the Deep Sea Drilling Projects, E. Christofferson and M. R. Fisk, Vol. XIII, pt. 2, Chap. 16, p. 581, 1970.

Correlation of a Trans-Tyrrhenian Reflection Profile with Site 132, E. F. K. Zarudzki, C. Morelli, I. Finetti, H. K. Wong, Vol. XIII, pt. 2, Chap. 17, p. 587, 1970.

Compressional Wave Velocity in Selected Samples of Gabbro, Schist, Limestone, Anhydrite, Gypsum and Halite, E. Schreiber, P. J. Fox and J. J. Peterson, Vol. XIII, pt. 2, Chap. 18, p. 595, 1970.

Evaluation of Physical Properties Measurements, J. M. Lort, Vol. XIII, pt. 2, Chap. 39, p. 1401, 1970.

Bathymetric, Magnetics, and Seismic Reflection Data: CHALLENGER Leg XIV, Dennis E. Hayes and Anthony C. Pimm, Vol. XIV, pt. 2, Chap. II, p. 341, 1970.

Physical Properties, Anthony C. Pimm, Vol. XIV, pt. 2, Chap. 18, p. 655, 1970.

Compressional Wave Velocities in Basalt and Altered Basalt Recovered During Leg XIV, Paul J. Fox and Edward Schreiber, Vol. XV, Chap. 31, p. 1013, 1970.

Physical Properties Summary, Robert C. Boyce, Vol. XV pt. 2, Chap. 38, p. 1067, 1970.

Physical Properties Evaluation, Richard H. Bennett and George H. Kellar, Vol. XVI, pt. 2, Chap. 13, p. 513, 1971.

Compressional and Shear Wave Velocities in Basaltic Rocks, Deep Sea Drilling Project, Leg 16, Nikolas I. Christensen, Vol. XVI, pt. 2, Chap. 24, p. 647, 1971.

Measurements of Porosity in Sediments of the Lower Continental Margin, Deep Sea Fans, the Aleutian Trench, and the Alaskan Abyssal Plain, Ronald von Huene, David J. W. Piper and John R. Duncan, Vol. XVII, pt. 2, Chap. 26, p. 889, 1971.

Physical Properties of Deformed Sediment from Site 181, Homa J. Lee, Harold W. Olsen, and Ronald von Huene, Vol. XVIII, pt. 2, Chap. 27, p. 897, 1971.

Preliminary Site Surveys in the Bering Sea for the Deep Sea Drilling Project, Leg 19, Daniel J. Fornari, Robert J. Iuliucci, and George G. Shor, Jr., Vol. XIX, pt. 3, Chap. 13, p. 569, 1971.

Compressional Shear Wave Velocities and Elastic Moduli of Basalts, Deep Sea Drilling Project, Leg 19, Nikolas I. Christensen, Vol. XIX, pt. 3, Chap. 17, p. 657, 1971.

Measurements and Estimates of Engineering and Other Physical Properties, Leg 19, Homa J. Lee, Vol. XX, pt. 3, Chap. 15, p. 319, 1971.

Physical Properties Synthesis, Leg 20, Deep Sea Drilling Project, George Z. Forristall, Vol. XX, pt. 2, Chap. 21, p. 319, 1971.

Triaxial Compression Tests, Leg 20, Deep Sea Drilling Project, Michael B. Smith, George Z. Forristall, Vol. XX, pt. 2, Chap. 21, p. 417, 1971.

R/V THOMAS WASHINGTON CRUISE ARIES V: Reconnaissance Seismic Reflection Profiles of Prospective DSDP Sites in the Northwest Pacific, Bruce C. Heezen and Marie Tharp, Vol. XX, pt. 2, Chap. 24, p. 429, 1971.

Site Survey Report: KANA KEOKI Sites 3 and 4 Honolulu to Ponape, 1971, R. G. Zachariadis, Vol. XX, pt. 2, Chap. 25, p. 487, 1971.

A Seismic Profile Between the Bonin Trench and 160°E, Thomas A. Davis, Vol. XX, pt. 1, Chap. 26, p. 505, 1971

Seismic Reflection Profiles Between Fiji, Guam, and Japan, Bruce C. Heezen and John W. Jones, Vol. XX, pt. 2, Chap. 28, p. 547, 1971.

Determination of Sedimentary Velocities Using Expendable Sonobuoys at DSDP, Leg 20 Drilling Sites, Northwest Pacific, E. John and W. Jones, Vol. XX, pt. 2, Chap. 30, p. 625, 1971.

Correlation of Seismic Reflectors, James E. Andrews, Vol. XXI, pt. 3, Chap. 12, p. 459, 1971.

Seismic Profiles Made Underway on Leg 22, John J. Veevers, Vol. XXII, pt. 2, Chap. 10, p. 351, 1972.

Correlation of Reflectors with Lithology for Site 212, George Carpenter, Vol. XXII, pt. 2, Chap. 15, p. 397, 1972.

Stratigraphic Seismic Section Correlations and Implications to Bengal Fan History, David G. Moore, Joseph R. Curray, Russell W. Raitt, and Frans J. Emmel, Vol. XXII, pt. 2, Chap. 16, p. 403, 1972.

Porosity, Density, Grain Density, and Related Physical Properties of Sediments from the Red Sea Drill Cores, Frank T. Manheim, Linda Dwight, and Rebecca A. Belastock, Vol. XXIII, pt. 4, Chap. 26, p. 887, 1972.

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V. Data Summary

SITE DATA

Position:
- Latitude 25°51.5′ N
- Longitude 92°11.0′ W

Date: 8/12/68
Time:
Water depth: 2827 meters
Location: Sigsbee Scarp

CORE DATA

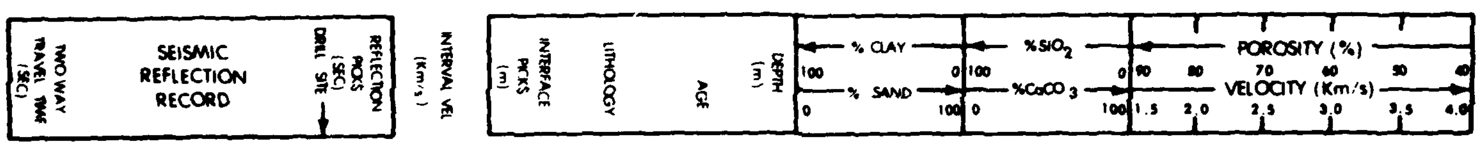
Penetration:
- Drilled-- 693 meters
- Cored---- 77 meters
- Total---- 770 meters

Recovery:
- Basement- 0 cores
- 0 meters
- Total---- 9 cores
- 50 meters

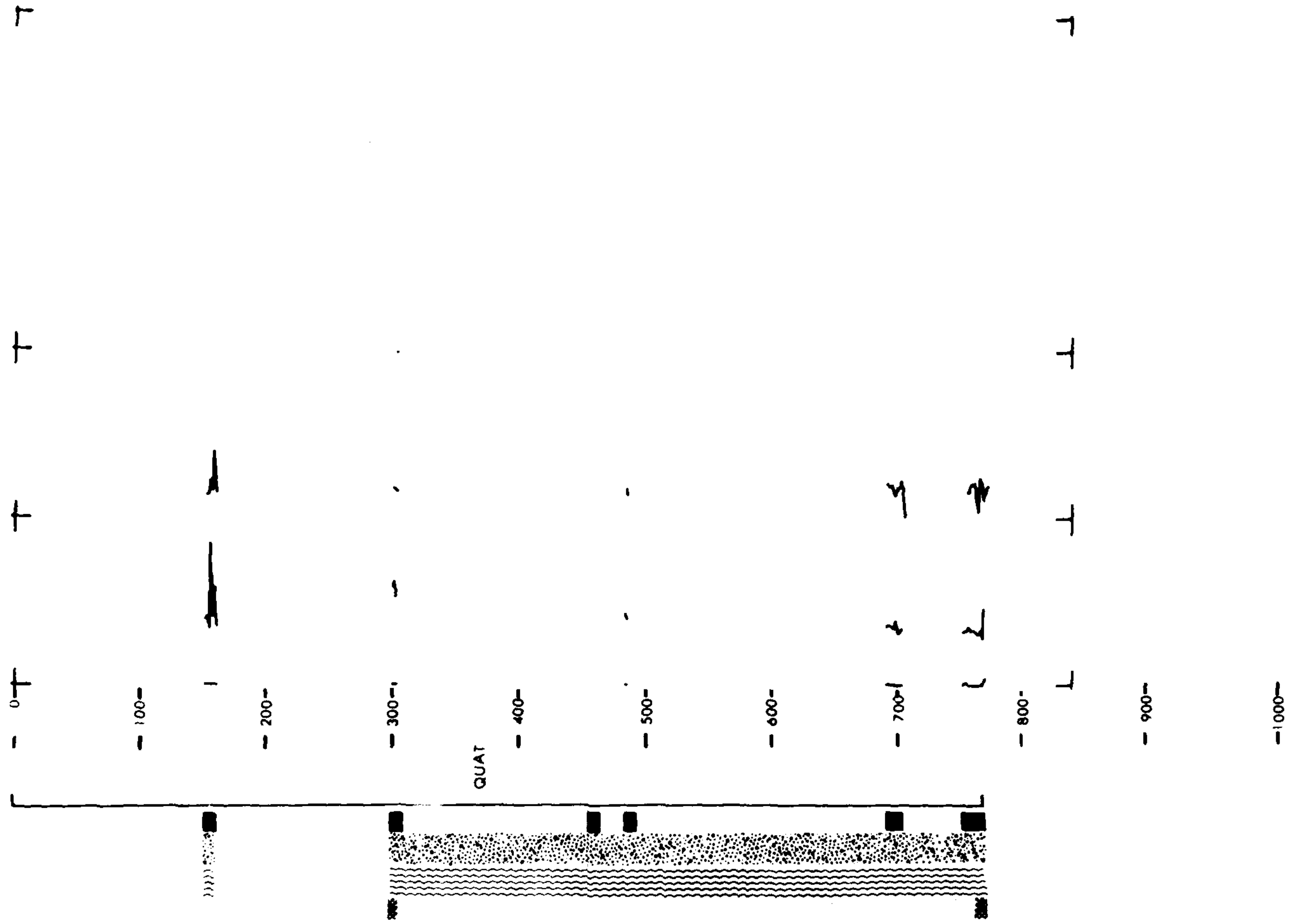
Both the basal massive mudstones and the overlying laminates are: chemically immature sediments, lacking in skeletal materials, full of carbonate rock flour, and may represent paraglacial sediment. Sedimentation throughout the time period represented by the cored section was rapid. The basal sediments seem to have been deposited in an area out of reach of most currents—quite possible on the face of the Sigsbee Scarp, or on the lower edge of the slope; the laminite facies, sediments, on the other hand, were deposited on a surface swept time and again by currents strong enough to carry silt—presumably low-energy turbidity currents. The uppermost stratigraphic unit clearly represents the postglacial sequence with its warmer and slower, though still comparatively rapid, sedimentation rate.

There is no certainty that the section penetrated is a normal stratigraphic sequence. Deformation shown by these cores consists of an intense chevron folding with horizontal axial planes. Some of the more strongly consolidated cores also show peculiar sub-horizontal, intersecting hackly fractures. This deformation is clearly a soft-sediment deformation, moving or moved in a down-dip direction, i.e., away from the Sigsbee Scarp.

One thin layer of calcareous sediment occurs at approximately 175 meters below subbottom.



SITE 1 LEG 1



SITE DATA

Position:
- Latitude 23° 27.3' N
- Longitude 92° 35.2' W

Date: 8/19/68
Time:
Water depth: 3572 meters
Location: Challenger Knoll

CORE DATA

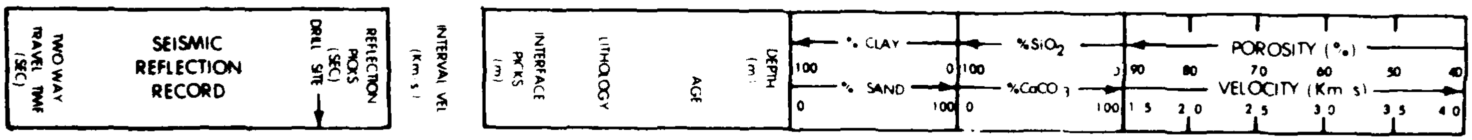
Penetration:
- Drilled-- 108 meters
- Cored---- 36 meters
- Total---- 144 meters

Recovery:
- Basement- 0 cores
  0 meters
- Total---- 6 cores
  13 meters

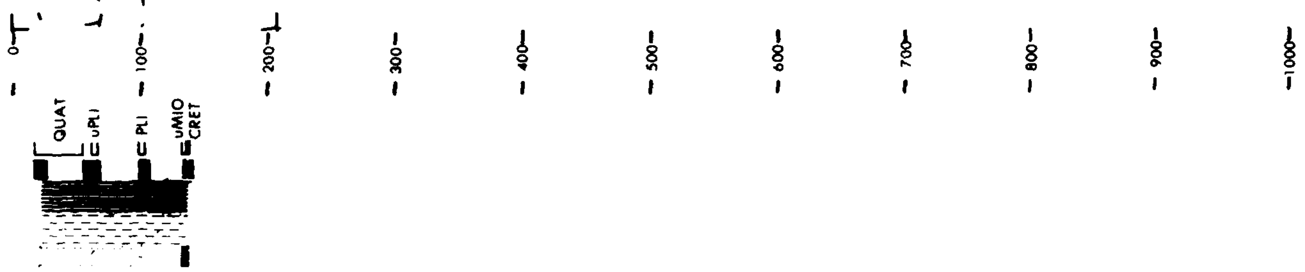
If it is assumed that sediments retrieved in Core 1 represent upper Pleistocene pelagites deposited contemporaneously with predominant turbidity current sediment distribution on the surrounding abyssal plain, then the downward transition from clay-rich pelagites in lower Pleistocene time to clay-poor, coccolith-rich pelagites in lower Pleistocene and Pliocene sediments corresponds well with the sequence observed at Site 3.

The presence of cap rock lithologies and associated mineralization similar to those described from salt domes on the northern continental shelf of the Gulf of Mexico is taken as clear evidence for the presence of salt at some unknown distance below the total depth of drilling in Hole 2. The presence of possible Miocene and certain Pliocene pelagic sediments on the crest of Challenger Knoll suggests that the knoll has been elevated above the surrounding plain since early Pliocene or Miocene time. The time of initial movement of the salt mass is unknown. Thinning of youngest Pleistocene and Holocene sediments on the knoll flanks, as observed by precision depth recording, suggests that vertical movement is still occurring.

Soft sediments nannofossil rich.



SITE 2 LEG 1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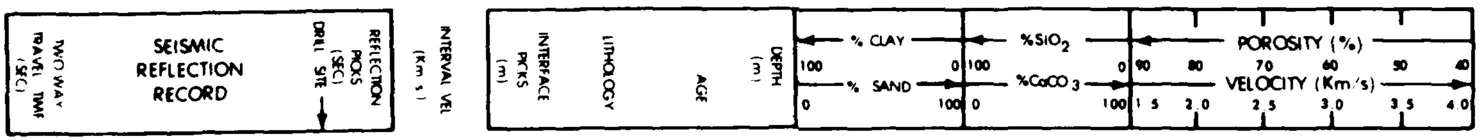
SITE DATA

Position:
Latitude 23°01.8' N
Longitude 92°02.6' W
Date: 8/21/68
Time:
Water depth: 3747 meters
Location: Sigsbee Deep

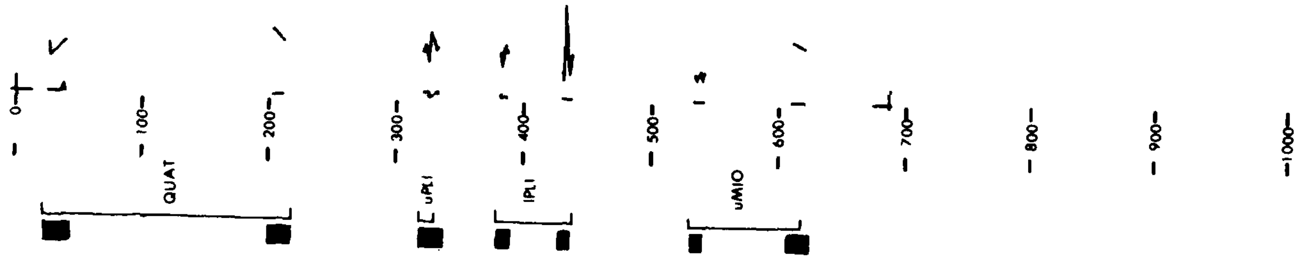
CORE DATA

Penetration:
Drilled-- 530 meters
Cored---- 98 meters
Total---- 628 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 11 cores
47 meters

The occurrence of two major types of turbidite sands and silts-terrigenous and organogenic- indicates that several source areas were feeding the abyssal plain during late Cenozoic time. One of these was presumably the Campeche Bank; the source of the terrigenous materials is to be sought in one or more deltas. Their association with volcanic debris suggests that the Miocene sands may have come from the Mexican highlands, while the Pleistocene ones are most likely derived from the Mississippi. During Pliocene time, normal pelagic sedimentation and carbonate influx from the Campeche Bank dominated sedimentation. Assuming that turbidity currents have been the dominant agent of transport of coarser material, some of those in Pleistocene time must have traveled three hundred miles.



SITE 3 LEG 1



SITE DATA

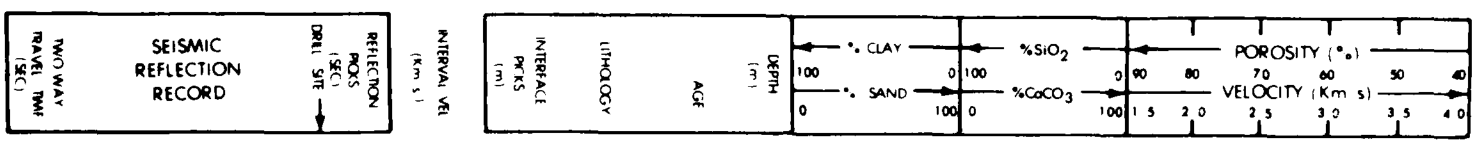
Position:
Latitude 24°28.7' N
Longitude 73°47.5' W
Date: 8/29/68
Time:
Water depth: 5319 meters
Location: Between the Hatteras Abyssal Plain and the Bahama Platform

CORE DATA

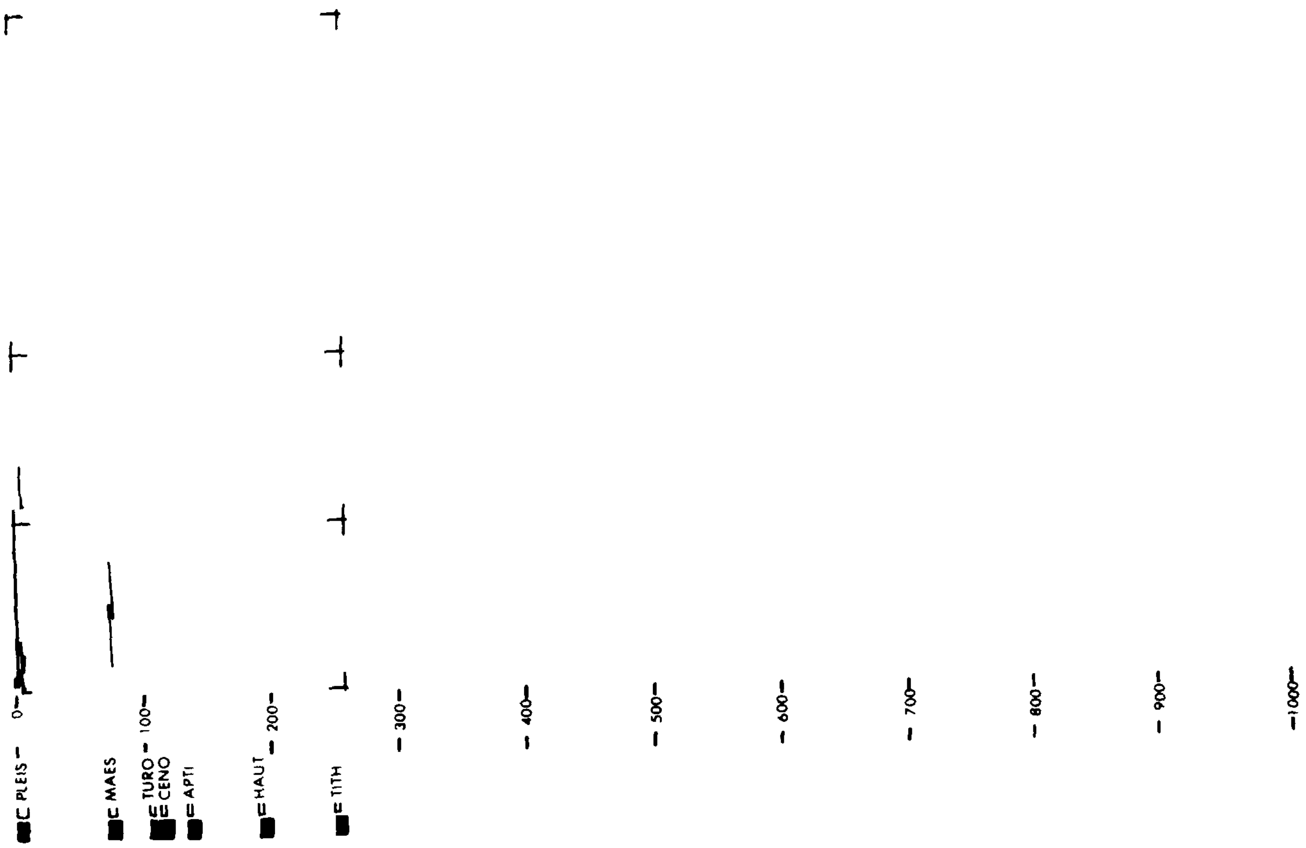
Penetration:	4	4A	
Drilled--	201	189	meters
Cored----	58	18	meters
Total----	259	207	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	5	3	cores
	15	5.8	meters

Sites 4 and 5 are discussed together. The sequence samples at Sites 4 and 5 represents nearly all of the Cretaceous and Tertiary ages. At Site 4, the Plio-Pleistocene was cored, Oligocene-Miocene fragments were recovered on the bit, Eocene-Oligocene cavings were found on top of one core, Maestrichtian, Campanian, Turonian, Cenomanian, Albian, Hauterivian, and older Neocomian were also cored.

Approximately 250 meters of sediment thus appears to represent about 125 x 10^6 years of time, an overall sedimentation rate of only 2 mm/10^3 years. This is an order of magnitude lower than the apparent rate for organic pelagic deposits, and a rate certainly not supported by the turbidites present. Rather than indicating an exceptionally low rate of sedimentation, the very thin section at Site 4 appears to result from a great many small gaps in the sequence. Throughout the Cretaceous and Tertiary this area was one which was largely bypassed, where most of the sediment was swept away, and where only intermittently some was preserved—a situation which appears to have persisted to the present.



SITE 4 LEG 1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SITE DATA

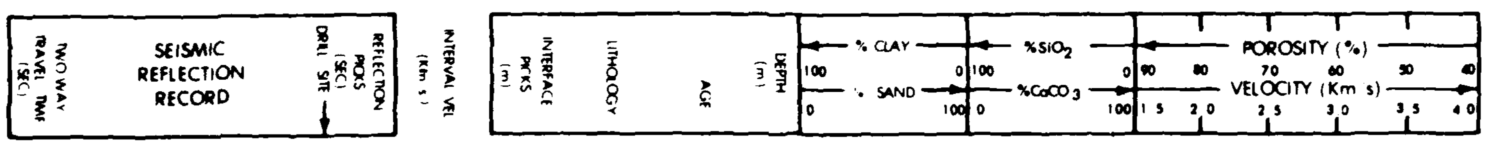
Position:
Latitude 24°43.6' N
Longitude 73°38.5' W
Date: 9/4/68
Time:
Water depth: 5354 meters
Location: Between the Hatteras Abyssal Plain and the Bahama Platform

CORE DATA

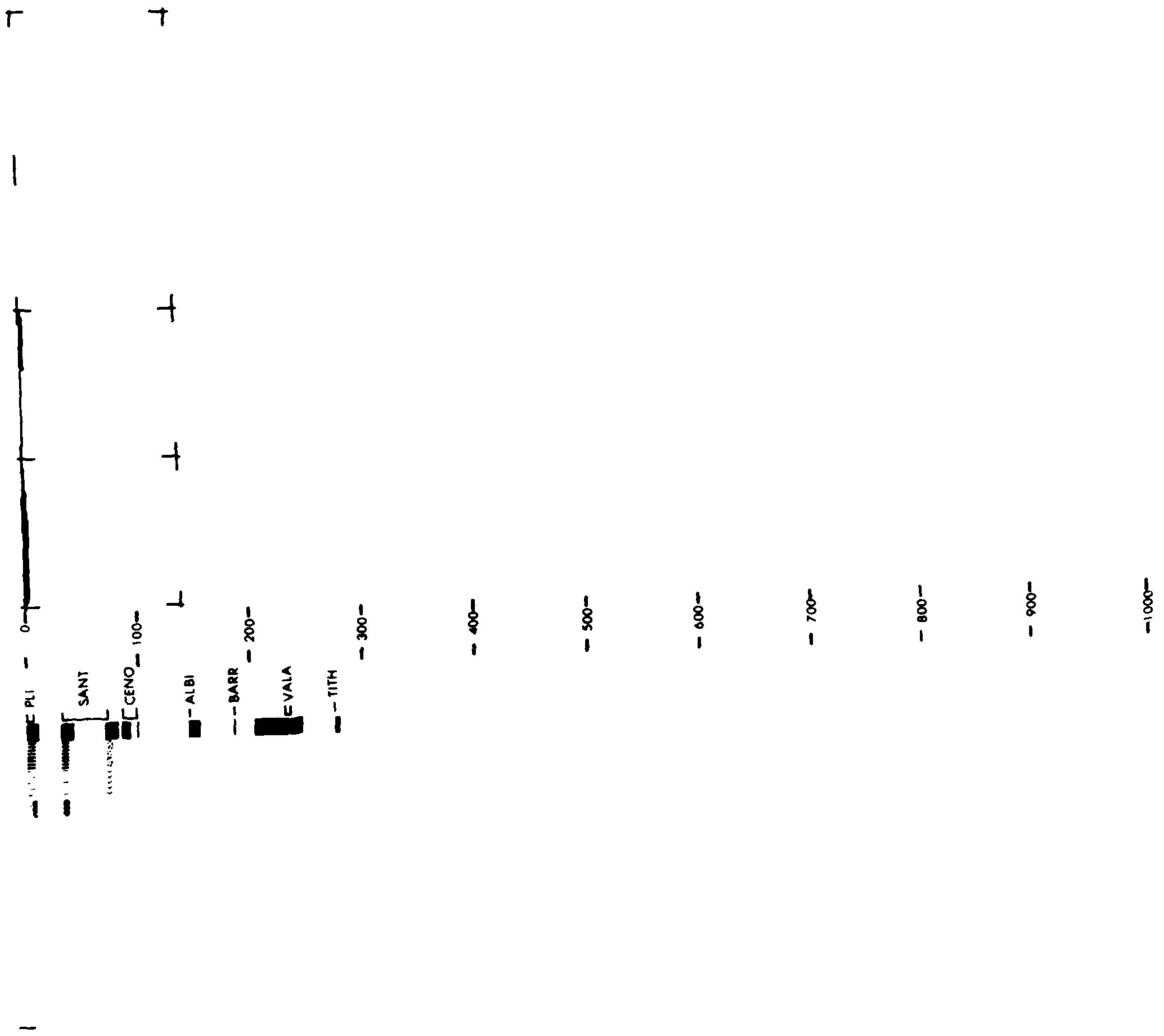
Penetration:	5	5A	
Drilled--	53	239	meters
Cored----	27	39	meters
Total----	80	278	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	3	7	cores
	6.4	1.8	meters

A quiescent period of pelagic carbonate sedimentation in Tithonian-Neocomian time was followed by a time when radiolarian oozes repeatedly replaced calcareous sediment (carbonate compensation depth), while mudflows brought in terrigenous pebbly mudstones. Calcareous pelagites dominated the Upper Cretaceous, while periodic turbidity currents brought in shelf sediment. The late Cenozoic was characterized by many disconformities, and continued resedimentation of older carbonates; brown clay became the normal pelagic background sediment. Throughout the Cretaceous there are signs of episodic bottom stagnation.

Calcareous sediment; rarely foraminifera or nannofossil rich.



SITE 5 LEG 1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SITE DATA

Position:
Latitude 30° 50.4' N
Longitude 67° 38.9' W
Date: 9/12/68
Time:
Water depth: 5124 meters
Location: Bermuda Rise

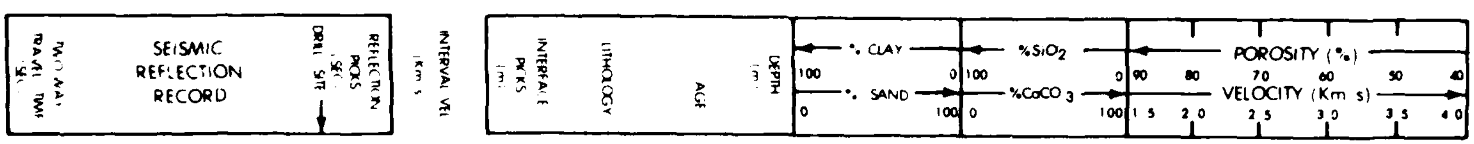
CORE DATA

Penetration:	6	6A	
Drilled--	210	24	meters
Cored----	47	0	meters
Total----	257	24	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	6	0	cores
	28	0	meters

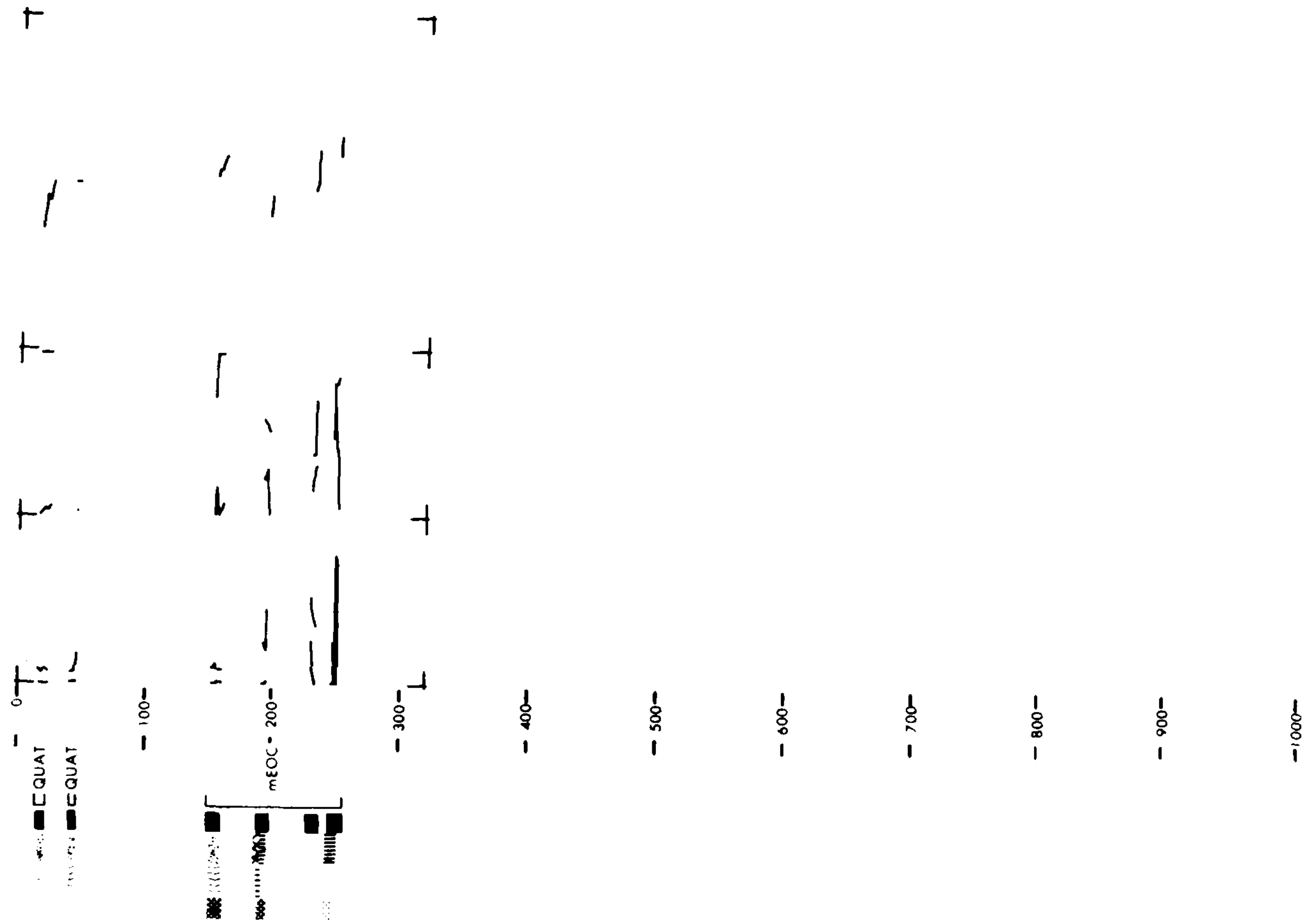
Site 6 lay below the carbonate compensation depth during the Eocene. The sands and silts at the base of the rhythms, and the chalks and marls of the middle were emplaced catastrophically by turbidity currents. The quartz grains are of terrigenous origin, and are probably resedimented from a temporary resting place on the shelf. The associated glauconite pellets either grew contemporaneously on the shelf, or they were derived by submarine erosion from somewhat older shelf sediments. The nanno-plankton-rich marls and chalks are of penecontemporaneous origin, and were most likely swept up by the turbidity currents on the continental slope and rise to be deposited on an abyssal plain.

The total sequence can be considered as a major cycle of sedimentation. Turbidity current sedimentation on an existing abyssal plain during Eocene time was subsequently replaced by a gradual change to pelagic sedimentation. Pelagic sedimentation was further changed by a gradual reduction in supply of volcanogenic debris in upper Tertiary time.

Siliceous sediment diatom rich. Calcareous sediment nannofossil or forminifera rich.



SITE 6 LEG 1



SITE DATA

Position:
- Latitude 30°08.0'N
- Longitude 68°17.8'N

Date: 9/12/68
Time:
Water depth: 5182 meters
Location: Bermuda Rise

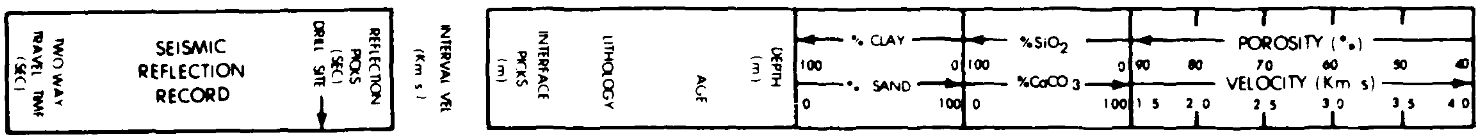
CORE DATA

	7	7A	
Penetration:			
Drilled--	226	276	meters
Cored----	10	20	meters
Total----	236	296	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	2	3	cores
	9.8	4.6	meters

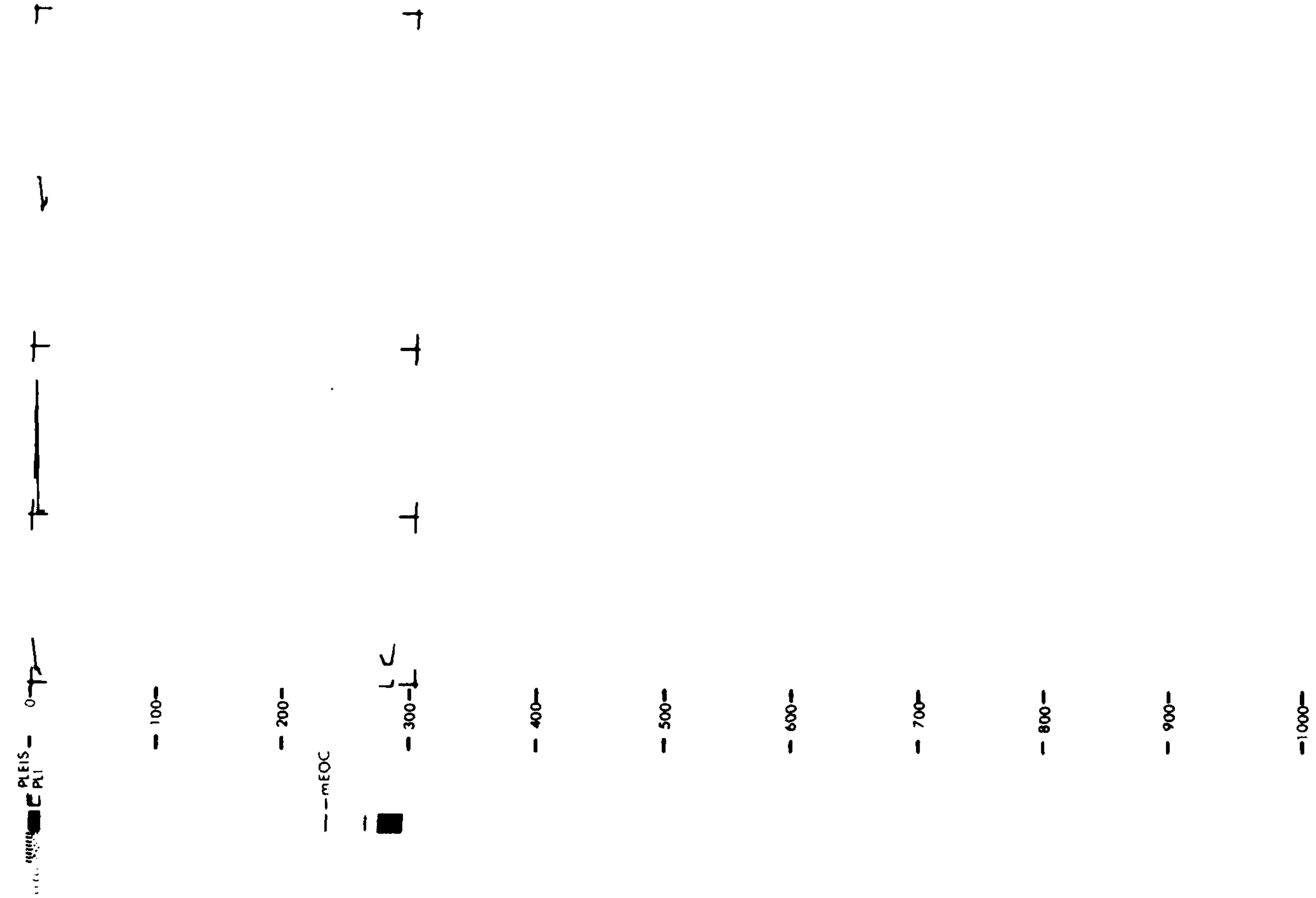
Sites 6 and 7 are separated laterally by only about 50 miles, and are thought to be stratigraphically correlative. The basal section of pelagic deep-sea red clay encountered at Site 7 is interpreted to represent the previously postulated earlier cycle of pelagic sedimentation. Conditions were evidently quite similar to late Tertiary deposition. It would appear, on the basis of these data, that the Bermuda Rise area has a complex history of formation, and that initial movements and formation of the Rise may well have started in Mesozoic time.

It is possible that by detailed study of interval thicknesses, one might arrive at definite conclusions regarding volcanogenic depocenters for the deep-sea red clays in the Bermuda region. It could be that earlier depocenters are clearly separated from later ones, thus possibly indicating something of the evolution and genesis of the Bermuda Rise. More tests to penetrate basement are clearly called for.

Calcareous sediment nannofossil rich.



SITE 7 LEG 1



SITE DATA

Position:
Latitude 35°23.0'N
Longitude 67°33.2'W
Date: 10 / 2 / 63
Time:
Water depth: 5184 meters
Location: Between Hatteras and Sohm Abyssal Plain

CORE DATA

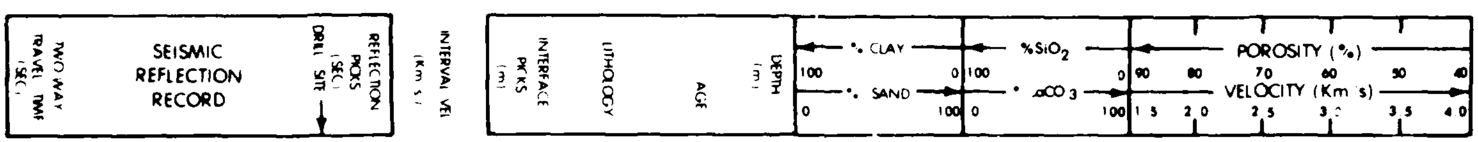
Penetration:	8	8A	
Drilled--	231	271	meters
Cored----	27	35	meters
Total----	258	306	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	3	4	cores
	4.7	3	meters

Some of the cherty sediments sampled contain significant silt-sized quartz and glauconite grains. These cherty siltstones occur at about the same stratigraphic level as turbidites which were sampled at Site 7, suggesting that the material from Hole 8A may also be of turbidity current origin, but reworked after transport to the deep ocean floor. It is possible that the silt-sized detritus observed in some of the Hole 8A cherts may have been derived from a northerly source area on the continental margin.

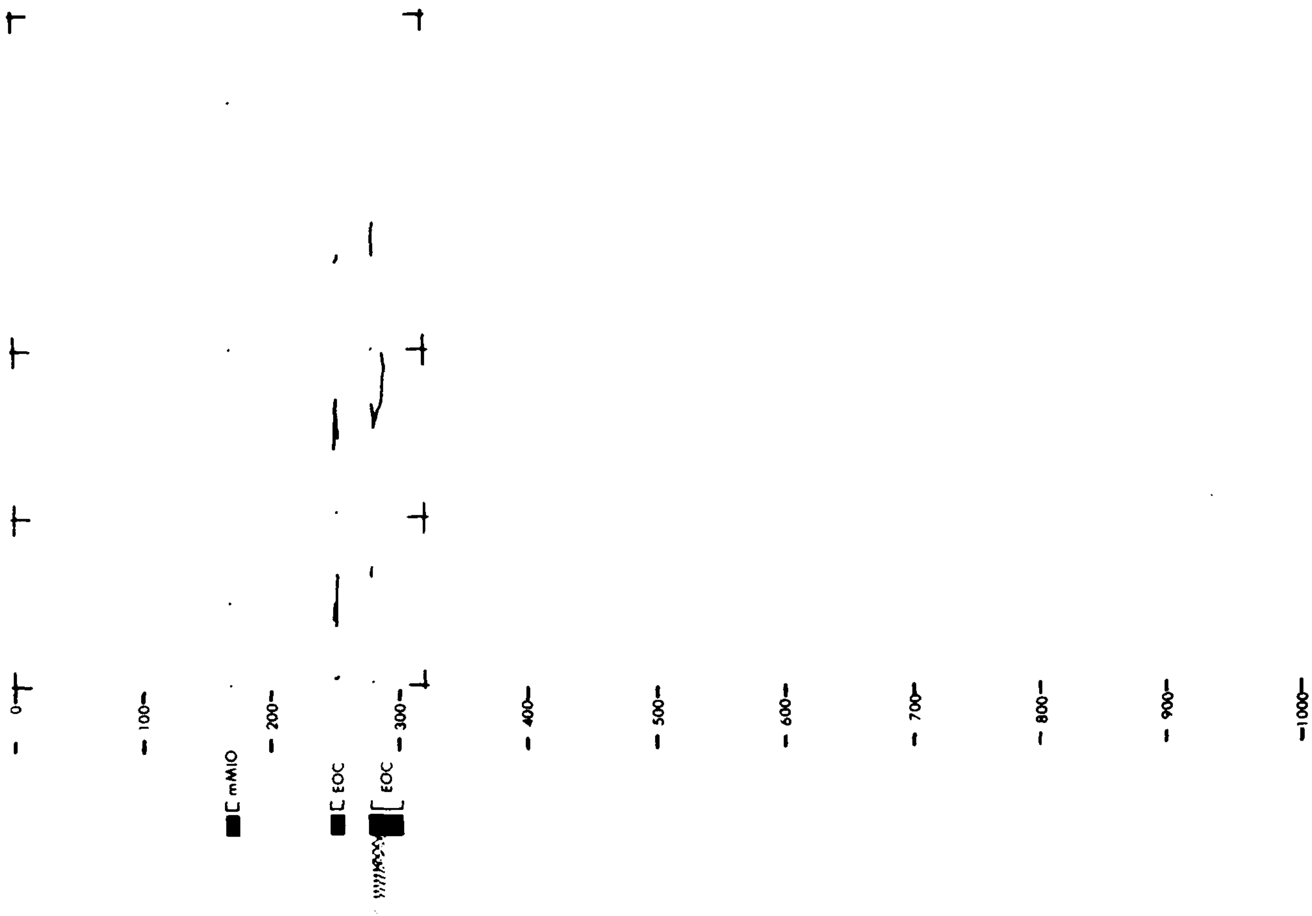
Soft sediment was penetrated below the chert;and, it is possible that the complete chert horizon was drilled. The intensity of Horizon A as a reflector diminished generally northward, appearing weak at Site 8 in accord with observed thickness variations measured by drilling.

Brecciated and slumped sediment form a surprisingly large proportion of the total sediment recovered. The observed disturbances were most probably caused by coring operations. However, the possibility remains that mud-flow type emplacement of sediment may have occurred.

Two thin layers of siliceous sediment; radiolaria rich, occurs in Eocene time.



SITE 8 LEG 2



SITE DATA

Position:
Latitude 32°46.4'N
Longitude 59°11.7'W
Date: 10 /21/68
Time:
Water depth: 4973 meters
Location: Bermuda Rise flank

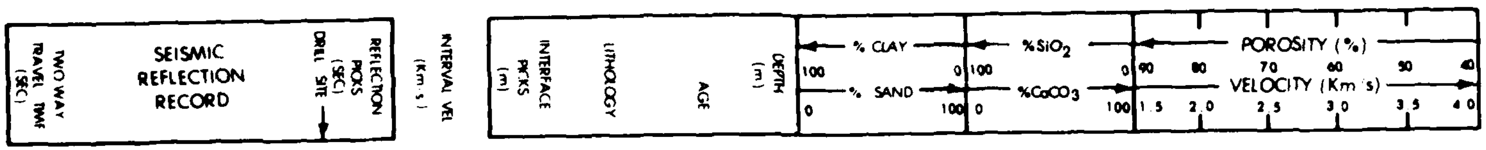
CORE DATA

	9	9A	
Penetration:			
Drilled--	390	802	meters
Cored----	102	32	meters
Total----	492	834	meters
Recovery:			
Basement-	0	1	cores
	0	.3	meters
Total----	12	6	cores
	36	11	meters

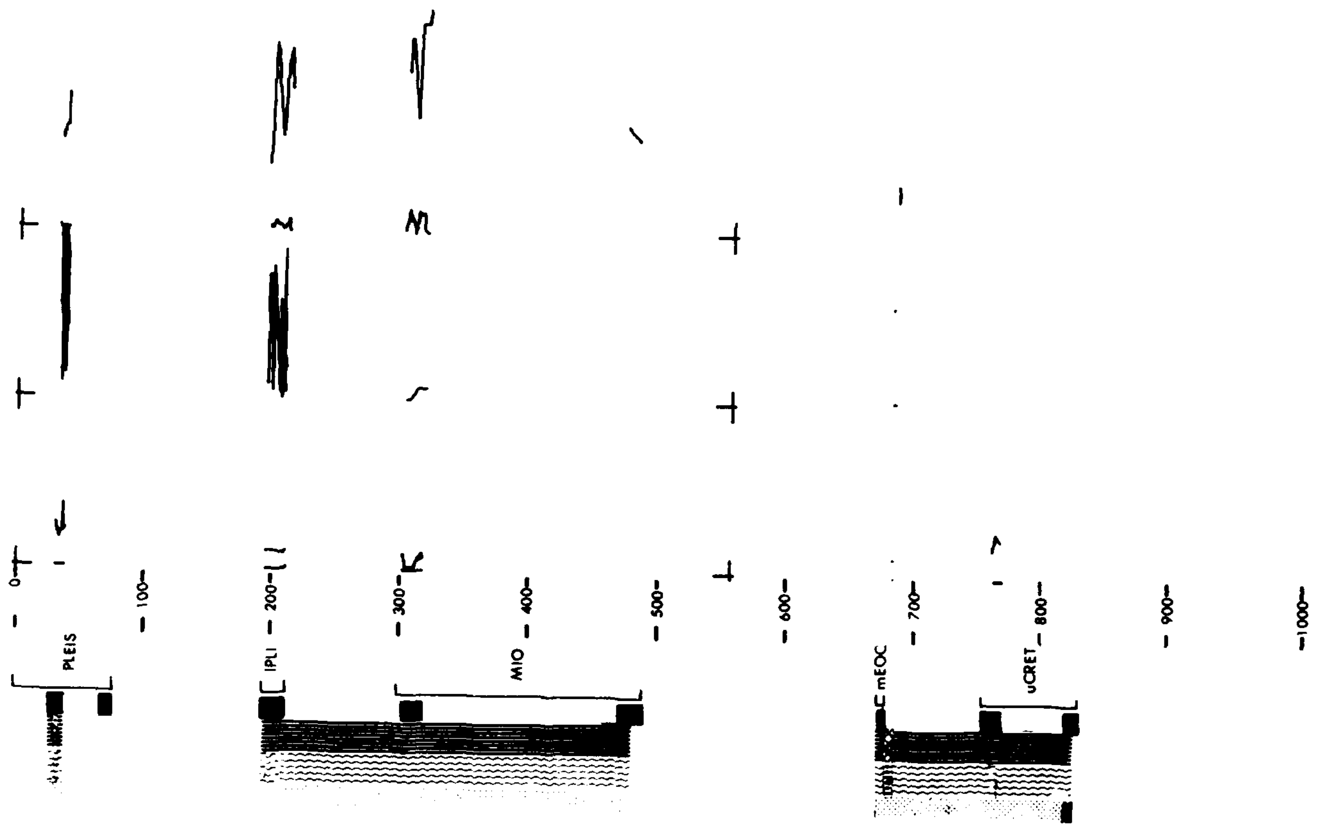
The thick accumulation of acoustically transparent sediment seen on profiler records is composed dominantly of clay. It is generally free of calcareous components, except in the Upper Cenozoic and Upper Eocene sections. Radiolaria are found rarely in the Quaternary cores and in somewhat greater numbers in the Eocene and Upper Cretaceous cores. These clays and zeolitics may have formed from the alteration of volcanic material that could have originated from seamounts in the area north and north-east of Bermuda. Most of the sediments have a reddish hue which increases in intensity near the basement where the consolidated clays are brick red. The red color stems from oxidized iron which may have originated from iron rich waters that emanated from the basement.

There were no turbidites sampled at Hole 9. However, there is a transition from non-calcareous red clay to foraminiferal calcareous deposits. It would appear that the rise uplifted the area from below to above the carbonate compensation zone during the late Miocene. However, no evidence was noted that would indicate the time at which the uplift was terminated.

Pleistocene and Pliocene; interbedded calcareous, occasionally nannofossil rich, and detrital sediments. One thin layer of calcareous and one thin layer siliceous sediment occurs in earlier sediments.



SITE 9 LEG 2



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SITE DATA

Position:
    Latitude   32°51.7' N
    Longitude 52°12.9' W
Date: 11 / 02 / 68
Time:
Water depth: 4712 meters
Location: Mid-Atlantic Ridge

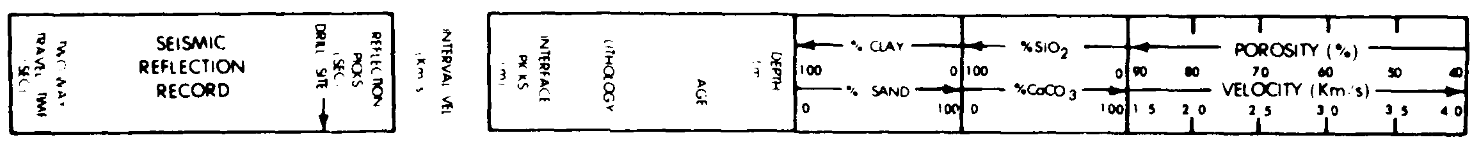
CORE DATA

Penetration:
    Drilled-- 288 meters
    Cored---- 171 meters
    Total---- 459 meters
Recovery:
    Basement-   2 cores
                3 meters
    Total---- 20 cores
               77 meters

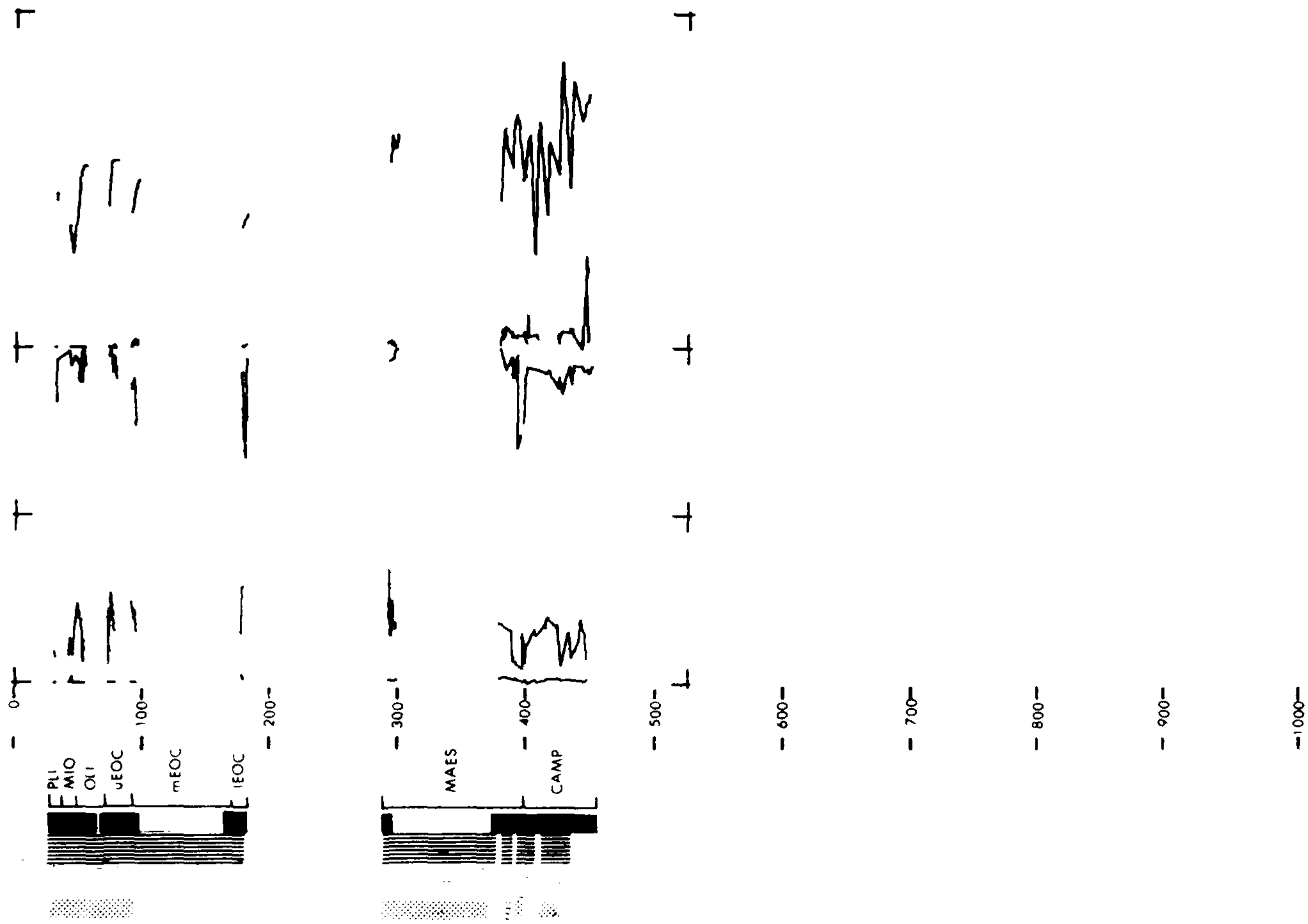
The sediment is predominantly calcareous throughout, which suggests that this area has remained above the effective calcium carbonate compensation depth from lower Campanian times to the Recent. In contrast, the sediment at Site 7, 8 and 9 apparently was deposited on the sea floor at a level below the compensation depth. Possible zeolites are found in the clays from the Eocene to late Miocene-scattered throughout and forming thin beds within calcareous oozes. These zeolites and clays may have been formed by the alteration of volcanic material possibly supplied by seamounts that lie to the north and northwest.

The deeper sediments immediately above volcanic basement, exhibit almost no signs of iron-enrichment. They appear to be unaltered and unconsolidated calcareous oozes right down to the basalt contact. The main changes with increasing depth are the increasing proportions of volcanogenic material and dolomite rhombs.

Sediments nannofossil rich.



SITE 10 LEG 2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PLI
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lEOC
MAES
CAMP

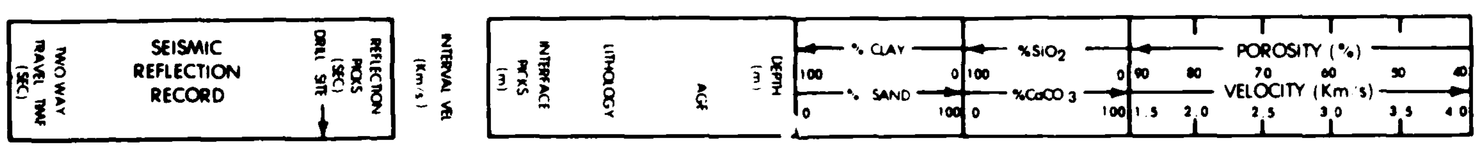
SITE DATA

Position:
Latitude $29^{\circ}56.6'$ N
Longitude $44^{\circ}44.8'$ W
Date: 11/09/68
Time:
Water depth: 3751 meters
Location: Mid-Atlantic Ridge

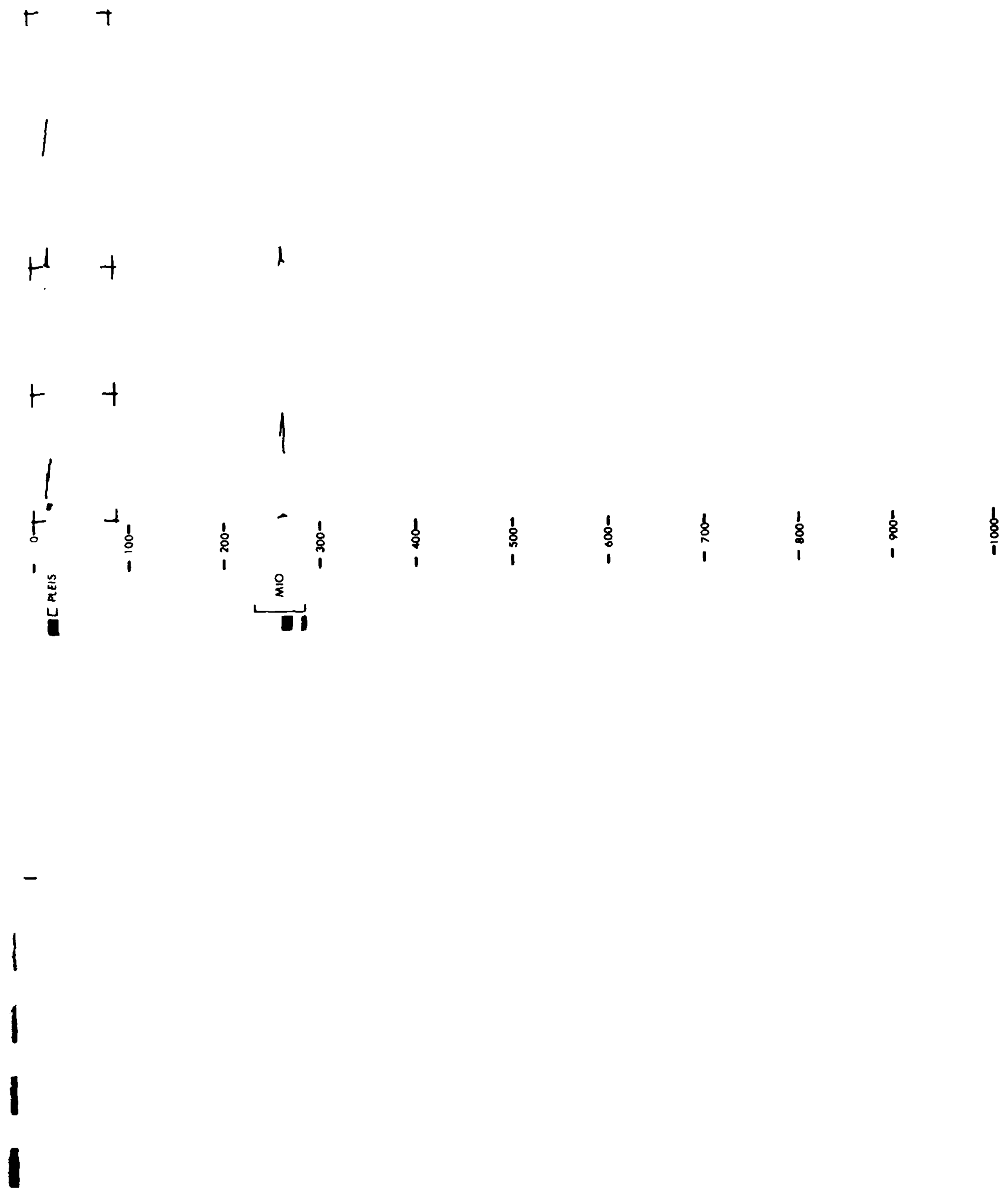
CORE DATA

Penetration:	11	11A	
Drilled--	14	235	meters
Cored----	9	49	meters
Total----	23	284	meters
Recovery:			
Basement-	0	2	cores
	0	.3	meters
Total----	1	8	cores
	6.1	6.7	meters

There was neither indication of red ferruginous staining such as that noted in the sediments overlying the basement at Site 9, nor of the presence of dolomite rhombs such as were observed at Site 10. The sediment immediately overlying the basement proved to be extremely difficult to core using our presently available techniques. The core barrels were returned to the surface often completely clean of even traces of sediment, because of the "soupy" nature of the calcareous sediment at this site. The surface core, as an exception, was relatively firm, but deeper sediment, within 100 feet of the basement, would literally flow in the core liner when slightly tilted and would not support the weight of penetrometer needle. The softness of this deeply buried sediment is of interest, and ability to flow at very low angles is pertinent in evaluating the sediment migration and distribution on the Mid-Atlantic Ridge. The water content of the sediment is not as great as might be anticipated from the softness of the sediments. The combination of high mobility with only moderate water content may be related to the fact that the major solid constituents are nannofossils.



SITE 11 LEG 2



SITE DATA

Position:
Latitude 19°41.7' N
Longitude 26°00.0' W
Date: 11/16/68
Time:
Water depth: 4557 meters
Location: Cape Verde Basin

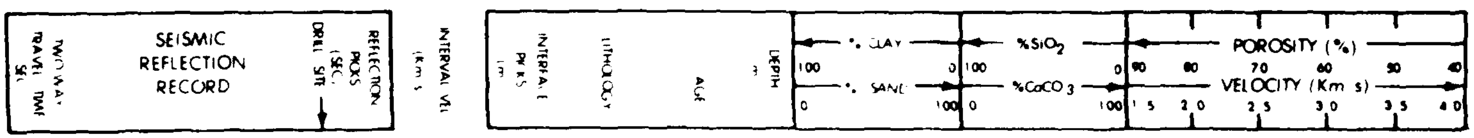
CORE DATA

Penetration:	12	12A	12B	12C	12D	
Drilled--	0	0	192	0	0	meters
Cored----	0	0	26	119	58	meters
Total----	0	0	218	115	37	meters
Recovery:						
Basement-	0	0	0	0	0	cores
	0	0	0	0	0	meters
Total----	0	0	4	13	7	cores
	0	0	2.7	30	39	meters

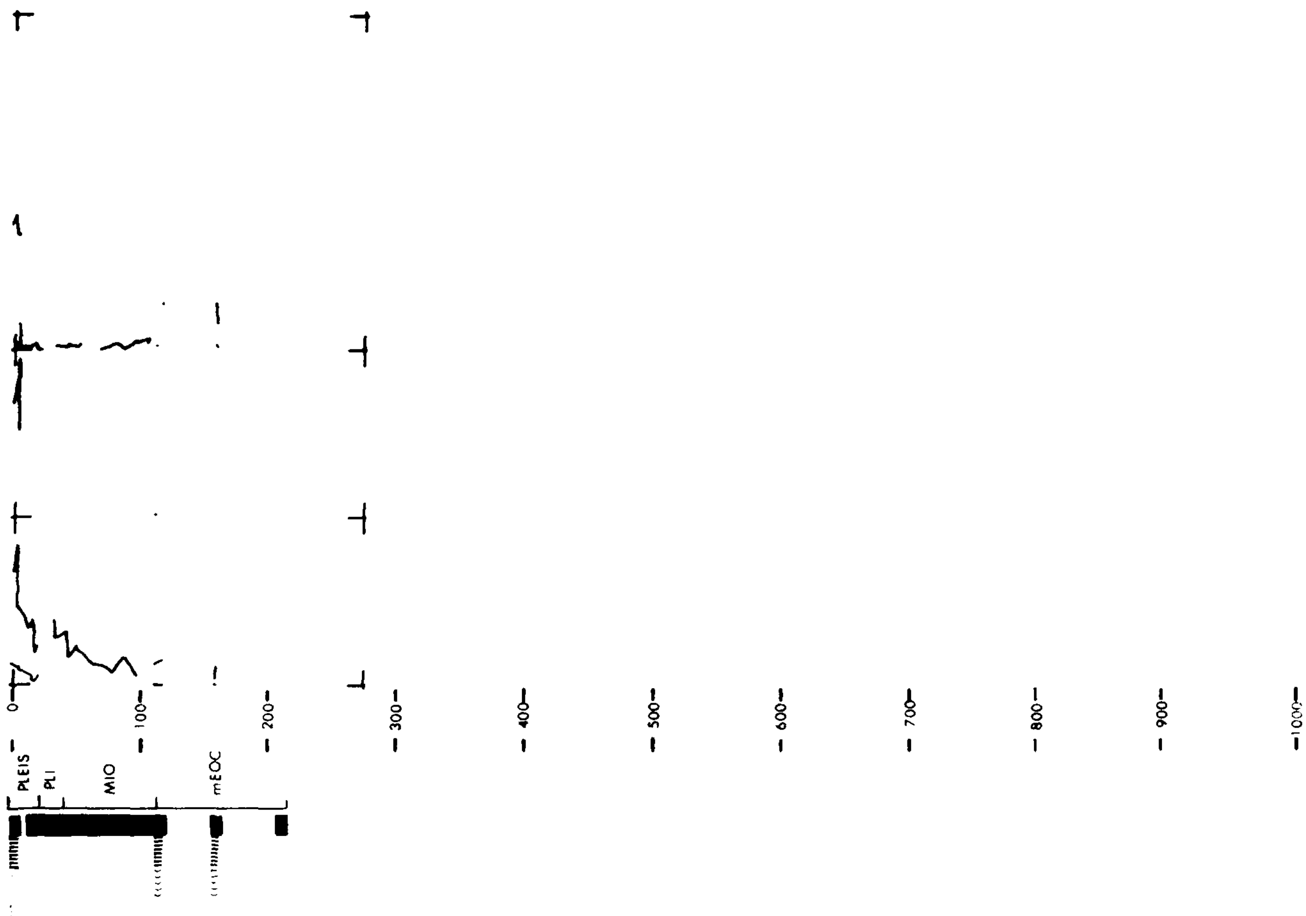
The sediments are of particular interest because of a thick interval of palygorskite (Attapulgite) and sepiolite, both magnesium rich clays. Palygorskite is rarely found in deep sea sediments. It is commonly associated with evaporite sediments or the hydrothermal alteration of serpentimites. The origin of palygorskite in the deep marine environment of Site 12 is not clearly understood.

The abrupt transition from a lower sequence of nonfossiliferous clay to Pliocene and Pleistocene calcareous ooze occurs within one 1.5 meter section. It is impossible to determine what caused this lithologic change: a rapid lowering of the calcium carbonate compensation depth, an increase in the productivity of the surface waters, or a change in the depth of water. The cherts appear indistinguishable from those found at Sites 8, 9, and 10. They contain and are associated with Eocene Radiolaria. Site 12 terminated on an unsampled hard layer which is directly overlain by dolomitic silt with zeolite and shard intercalations. It is possible that the hard layer underlying the dolomitic clay is basalt.

Pleistocene, calcareous sediment; foraminifera rich.



SITE 12 LEG 2



SITE DATA

Position:
Latitude $6^{\circ}02.4'$ N
Longitude $18^{\circ}13.7'$ W
Date: 12 / 03 / 68
Time:
Water depth: 4585 meters
Location: Sierra Leone Rise

CORE DATA

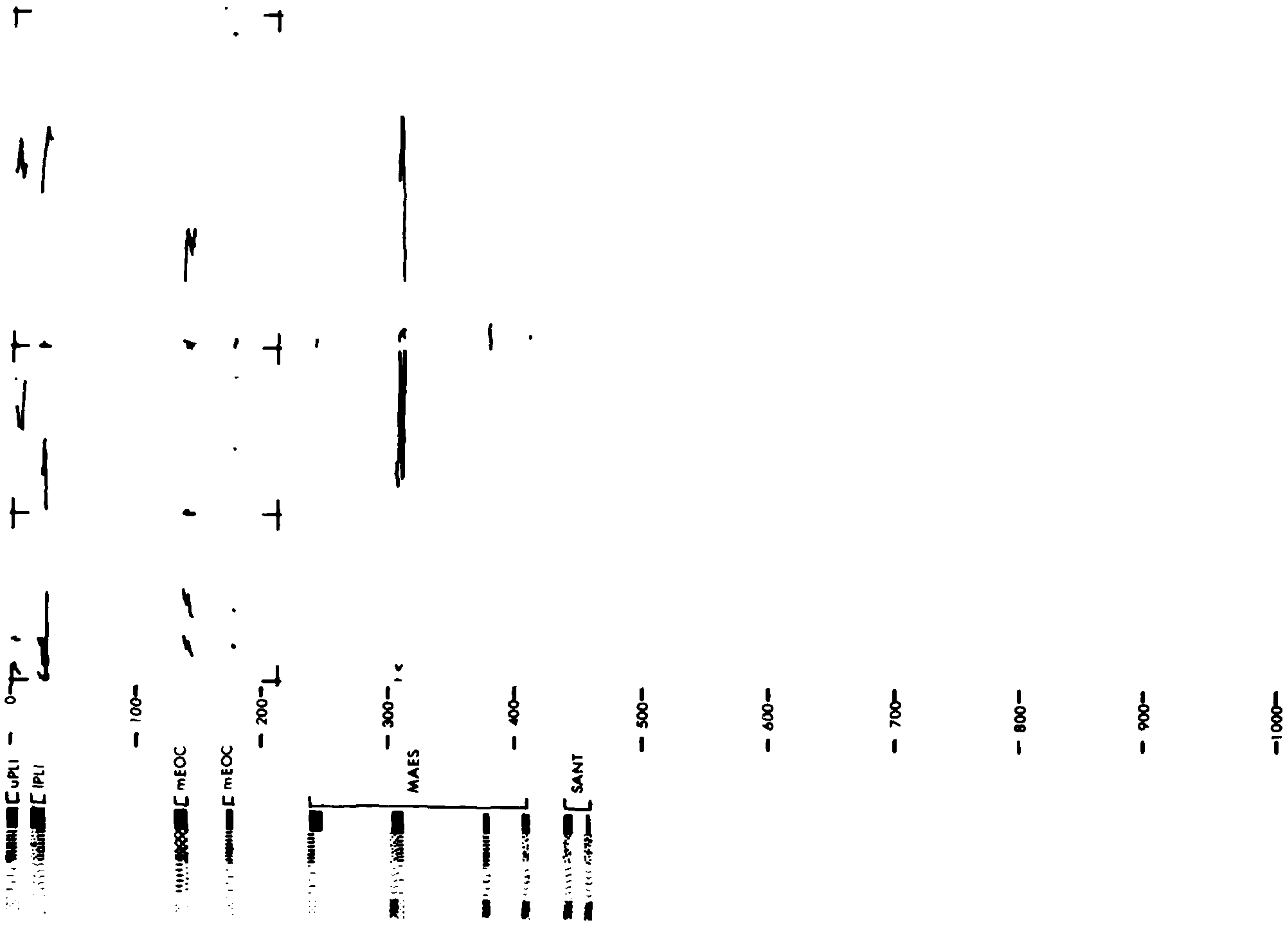
Penetration:	13	13A	
Drilled--	118	430	meters
Cored----	27	33	meters
Total----	145	463	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	3	7	cores
	26	11	meters

The Pliocene unit consists of interbedded nannofossil chalk oozes, marl oozes and brown zeolitic clays. The cores have been badly disturbed; the low calcium carbonate content is low for a chalk ooze, but this may have resulted in part from a mixing of the chalk oozes with the clays during the coring. The second unit is a brown zeolitic clay, very low in calcium carbonate content and barren of identifiable fossils. The third unit is light greenish-gray to grayish-yellow green deposits of siliceous planktons. The oozes are very homogeneous, very poorly consolidated and very porous. Intercalated are stringers of hard chert. Unit numbered 3-13A-2-1 (4th) consists of very pale green to green-gray, firm nannofossil oozes and clays. The nature of the two lowest formations was interpreted on fragmentary evidence: represented by small rock chips in gray mud matrix. Fifth unit; vitreous cherts, gray to dark gray laminated dolomitic cherts and limestone, and gray radiolarian sediments. The last; red shale with five or six hard chert layers, the last of which may have prevented further penetration on the hole.

Upper Pliocene sediments foraminifera and nannofossil rich. Late Pliocene, Middle Eocene, and Maestrichtian sediments nannofossil rich.

TWO WAY TRAVEL TIME (SEC)	SEISMIC REFLECTION RECORD	REFLECTION PICKS (SEC) DRILL SITE	INTERVAL VEL (Km/s)	INTERFACE PICKS (m)	LITHOLOGY	AGE	DEPTH (m)	% CLAY 100–0 / % SAND 0–100	%SiO₂ 100–0 / %CaCO₃ 0–100	POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 13 LEG 3



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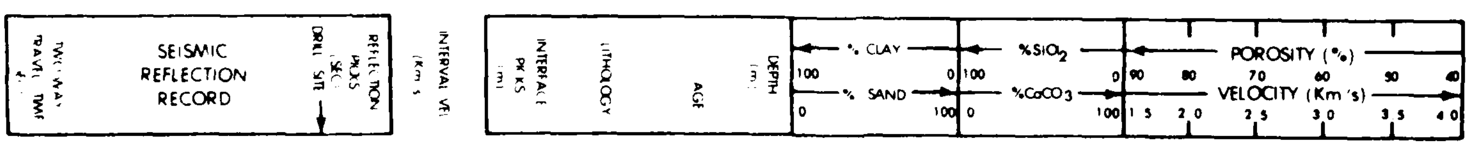
uPLI
lPLI
mEOC
mEOC
MAES
SANT

SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	28°20.0' S	Drilled--	15 meters
Longitude	20°56.5' W	Cored----	92 meters
Date: 12/20/68		Total----	107 meters
Time:		Recovery:	
Water depth: 4343 meters		Basement-	1 cores
Location: Negative Magnetic			1 meters
Anomaly; S. Atlantic		Total----	10 cores
Ocean			79 meters

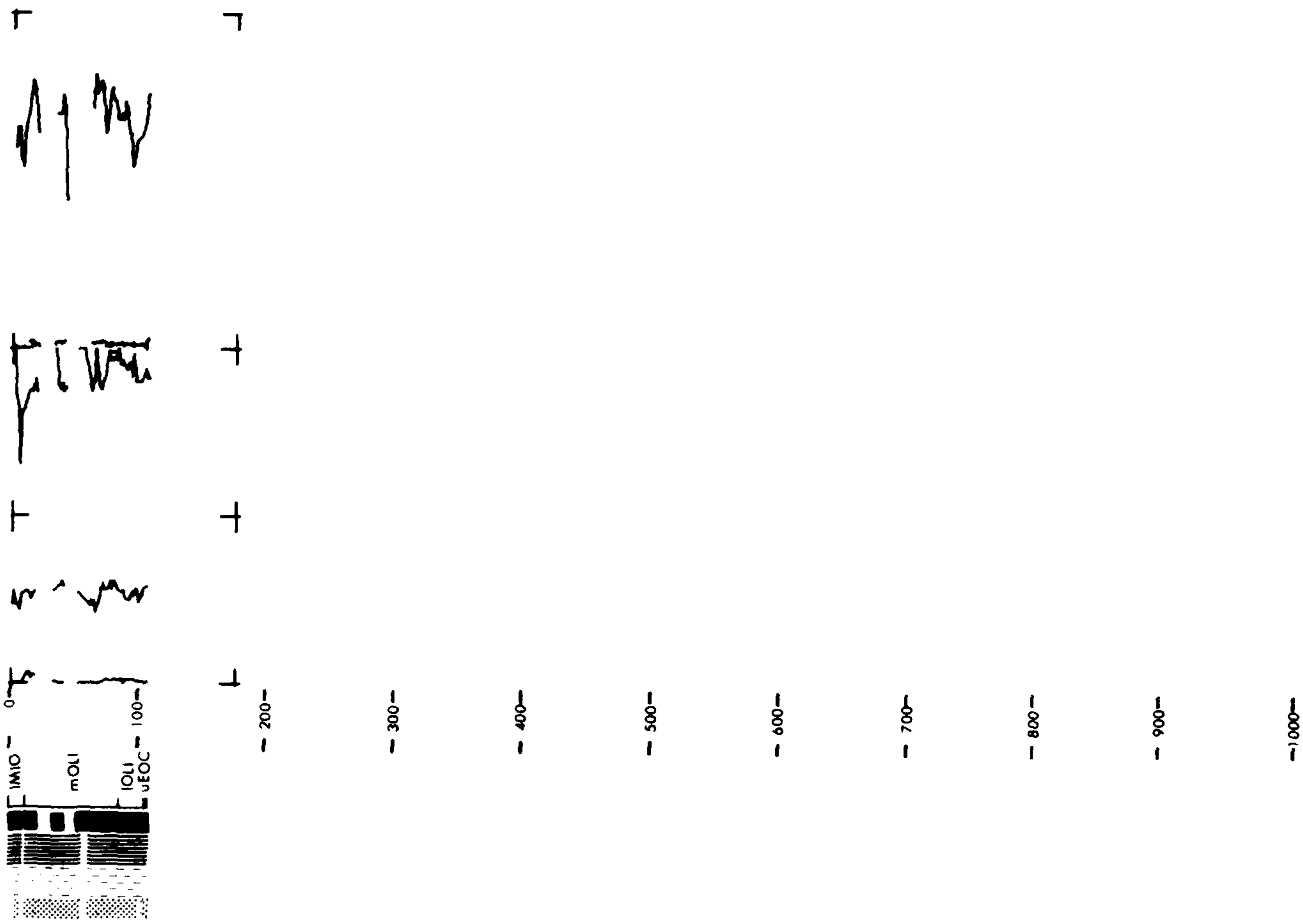
Three formations were encountered above the basement; in descending order: Endeavor Ooze; Fram Ooze-with Braarudosphaera Chalk member, a widespread Oligocene marker bed; and Grampus Ooze. The Endeavor Ooze is distinguished from the underlying Fram Ooze by the presence of relatively large amounts of the non-carbonate constituents. The zeolite content is noticeably high, especially in the marl oozes and red clays. The Grampus Ooze is dark nannofossil chalk oozes and marly chalk oozes.

The basement consists of marbles and basalts. Coarse-grained white, and fine-grained red-purple marbles occur at the top of the core. The top of the main basalt section is marked by a horizontal layer of black basaltic glass 5 mm thick. This grades downward into weathered cryptocrystalline basalt, then into a relatively fresh, dark aphanitic basalt. The basalt is traversed by calcite veins, and may represent a sill, intrusive beneath a layer of sediments.

All sediments nannofossil rich, upper Oligocene also rarely foraminifera rich.



SITE 14 LEG 3



SITE DATA

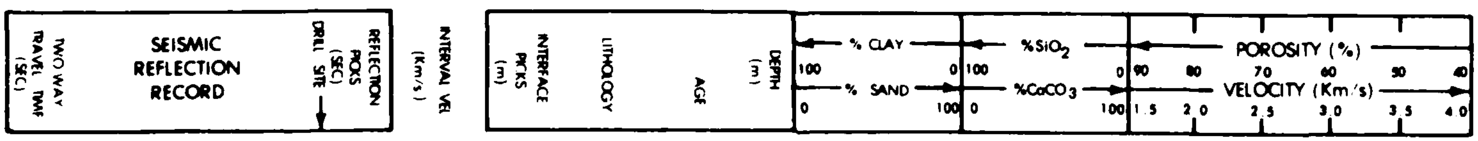
Position:
  Latitude   30°53.4' S
  Longitude 17°59.0' W
Date: 12/24/68
Time:
Water depth: 3927 meters
Location: Positive Magnetic Anomaly 6, Mid-Atlantic Ridge

CORE DATA

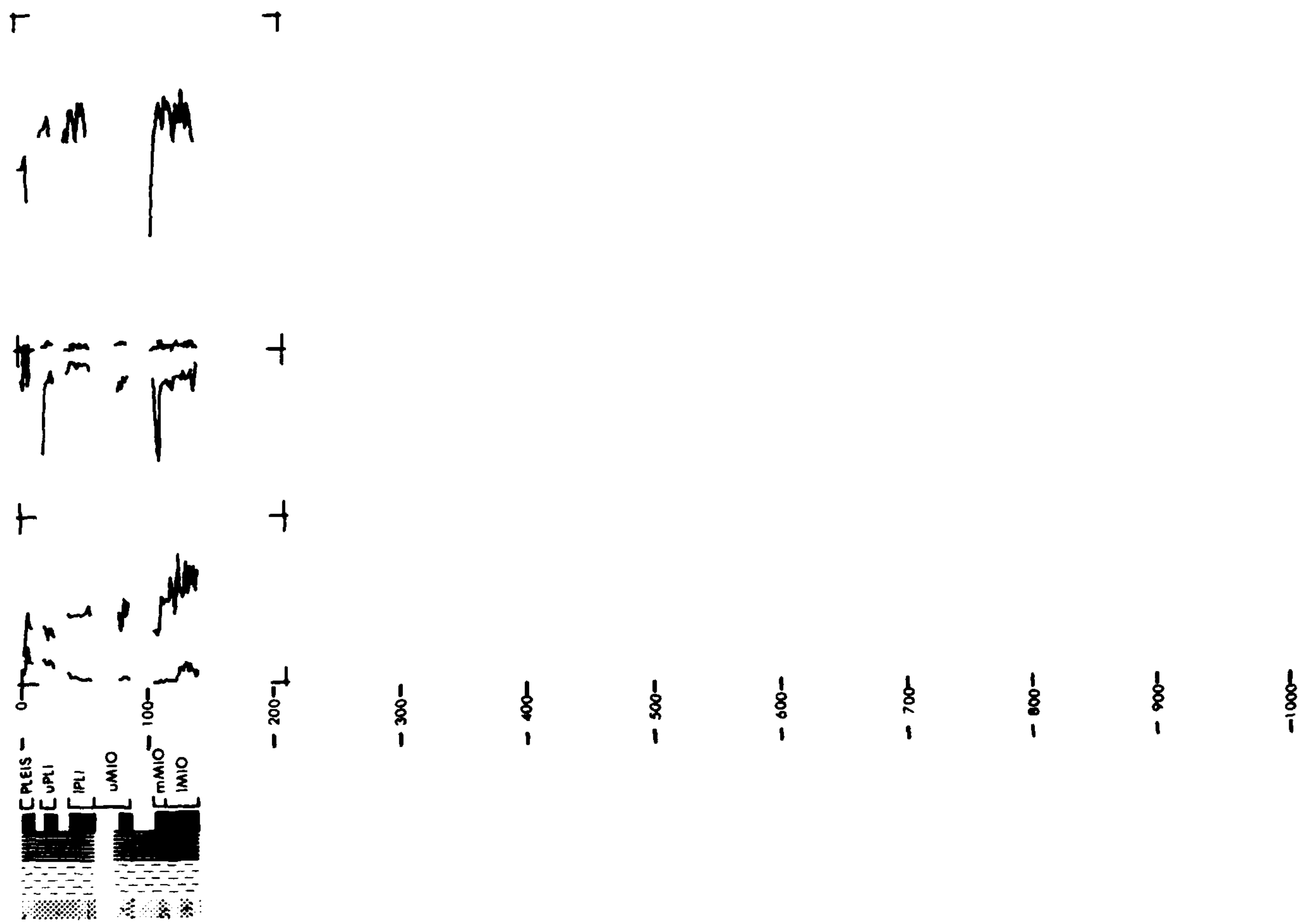
Penetration:
  Drilled-- 59 meters
  Cored---- 83 meters
  Total---- 142 meters
Recovery:
  Basement- 2 cores
  .45 meters
  Total---- 11 cores
  80 meters

The Plio-Pleistocene Albatross Formation is represented by Foraminiferal nannofossil chalk oozes. A significant difference was noted between the very pale brown color of the upper unit and the chalky white color which typifies the Blake Ooze (2nd unit). The Upper Miocene unit (3rd) consists of brown marly chalk oozes and includes considerable non-carbonate impurities, distinguishing this formation from the lighter and purer Blake Ooze above. The 4th unit includes dark brown nannofossil marl oozes and dark reddish-brown nannofossil clays, and represents the Discovery Clay. Underlying the red clays are brown marly chalk oozes with various colors. The shades of colors are related to the content of hematite and opaque iron minerals. These units were correlated with those at Sites 14, 17 and 18, as the Endeavor and Grampus Oozes. The facies represented by the Fram Ooze cannot be recognized as a separated unit at this site. Underlying the Grampus Ooze is the basalt basement. This dark gray aphanitic rock is probably a flow.

All sediments nannofossil rich.



SITE 15 LEG 3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uPLI
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lMIO

SITE DATA

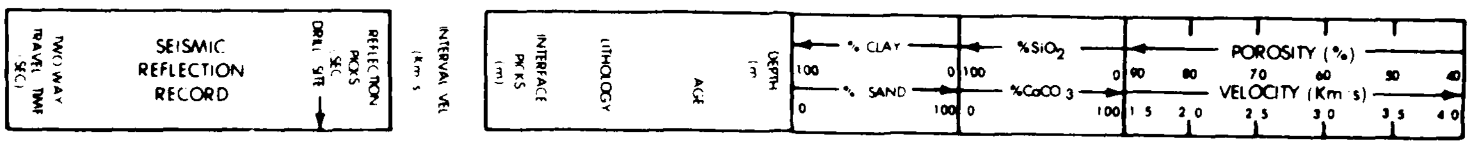
Position:
Latitude 30°20.1' S
Longitude 15°42.8' W
Date: 12/28/68
Time:
Water depth: 3527 meters
Location: Positive Magnetic Anomaly 5, Mid-Atlantic Ridge

CORE DATA

Penetration:
Drilled-- 76 meters
Cored---- 100 meters
Total---- 176 meters
Recovery:
Basement- 1 cores
.3 meters
Total---- 12 cores
99 meters

The late Cenozoic Albatross Ooze is a pale brown to white foraminiferal nannofossil chalk ooze. These sediments are particularly rich in foraminifera. The Plio-Miocene Blake Ooze was separated from the unit above by a color change and by a decrease in the foraminifera content. Like its correlative at Site 15, this unit has the chalky white color. The Challenger Ooze consists also of nannofossil chalk oozes. It has been recognized mainly because of the brown colors. The correlation is ventured on the basis of their corresponding stratigraphic position, and of a parallel evolution in their lithological characters. In assigning this unit as a part of the Challenger Ooze, the authors recognized a lateral facies change of this formation from dark marly zeolitic chalk oozes to lighter, less marly, non-zeolitic oozes; a change which may correspond to a decrease in ocean depth toward the axis of the Mid-Atlantic Ridge. Only a very small chip, some 1 mm^3, of dark gray aphanitic basalt was recovered.

Calcareous sediments nannofossil rich. One thin layer of detrital sediment occurs in upper Miocene time.



SITE 16 LEG 3

SITE DATA

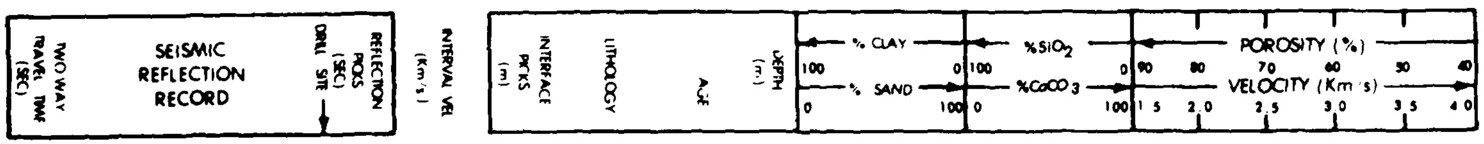
Position:
    Latitude 28 °02.7' S
    Longitude 6 °36.1' W
Date: 12/30/68
Time:
Water Depth: 4265 meters
Location: Negative Magnetic Anomaly, Mid-Atlantic Ridge

CORE DATA

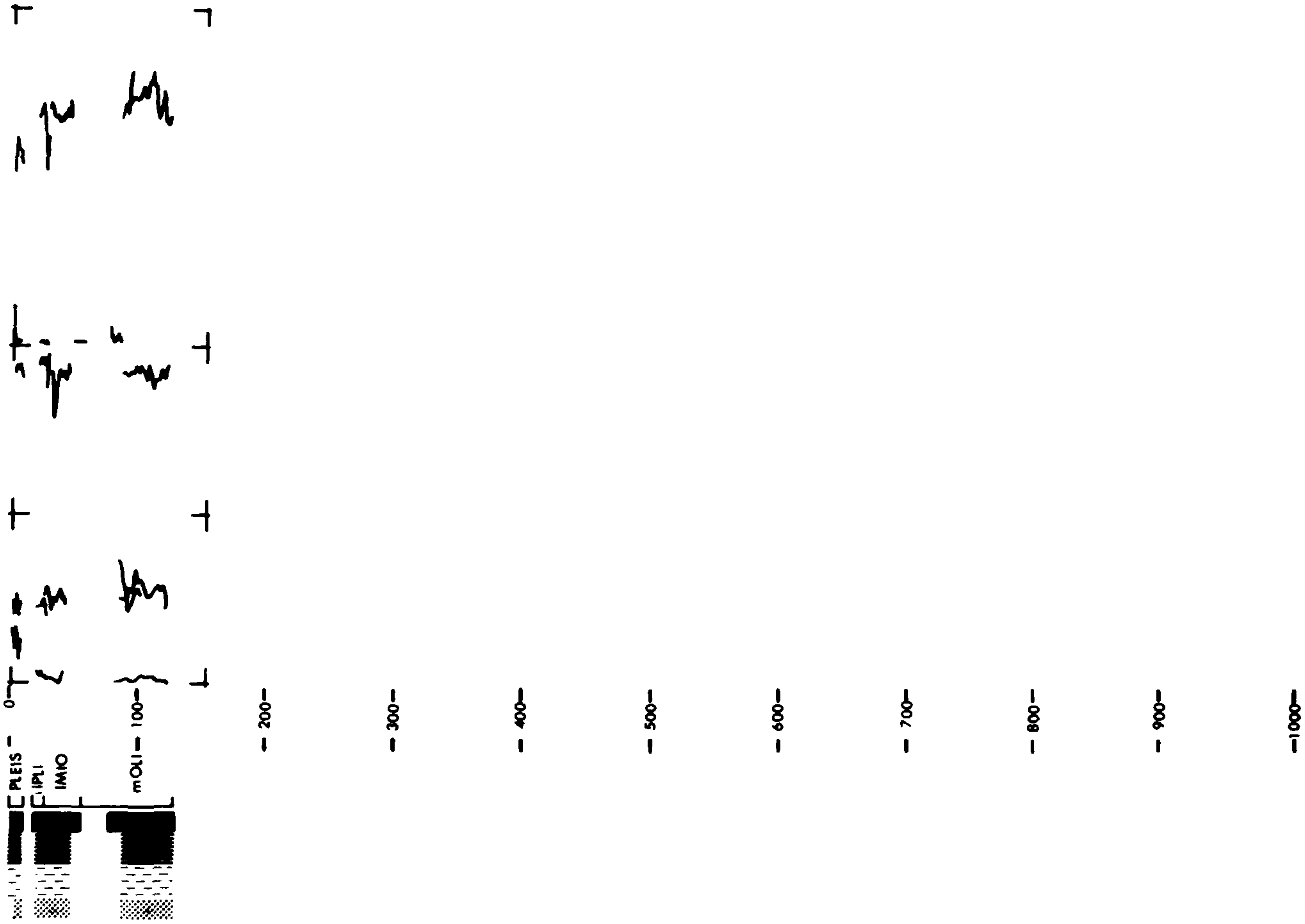
Penetration:	17	17 A	17 B	
Drilled--	56	67	88	meters
Cored----	37	36	40	meters
Total----	93	102	127	meters
Recovery:				
Basement-	0	1	1	cores
	0	.3	.3	meters
Total----	5	4	5	cores
	36	35	36	meters

The five units here can be correlated with those at adjacent sites. The Albatross Ooze here consists of the usual very pale brown foraminiferal nannofossil chalk oozes. The underlying Blake Ooze includes mainly white chalk oozes, which consist almost exclusively of nannofossils, with traces of foraminifera and the diatom Ethmodiscus rex. However, the lower part of the unit includes some diatom-rich layers. The 3rd unit, Lower Miocene, representing the Endeavor Ooze, underlies the Pliocene Blake Ooze disconformably. The Challenger Ooze and Discovery Clay at Site 15 are absent here. The Fram Ooze is represented by nannofossil chalk oozes. The remarkable thin layer of the white crystalline chalk, consisting exclusively of Braarudosphaera pentelets, first observed at Site 14, was again found at Site 17, Light yellowish-brown foraminiferal oozes are lithologically similar to the Grampus Ooze Formation. A hard basalt layer was reached in all three holes. They consist of plagioclase phenocrysts in a glassy matrix. The authors found no positive indication that this basalt is not a basement.

All sediments nannofossil rich



SITE 17 LEG 3



SITE DATA

Position:
- Latitude 27°58.7' S
- Longitude 8°00.7' W

Date: 1 /02/69
Time:
Water depth: 4018 meters
Location: Mid-Atlantic Ridge

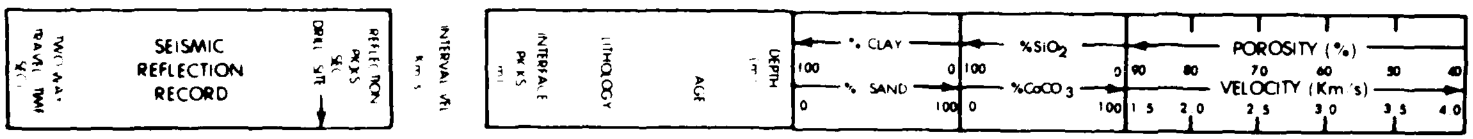
CORE DATA

Penetration:
- Drilled-- 125 meters
- Cored---- 53 meters
- Total---- 178 meters

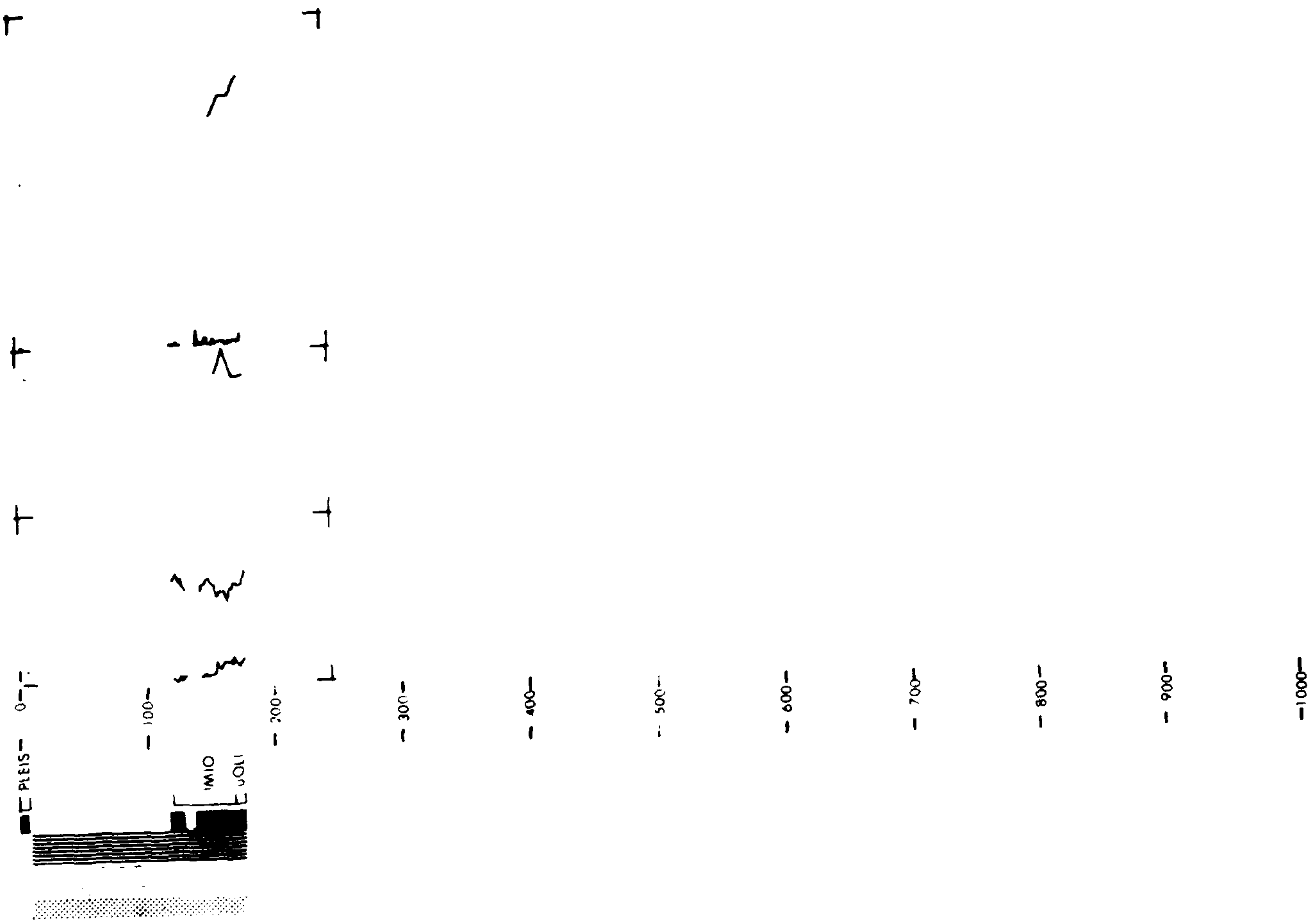
Recovery:
- Basement- 1 cores
- .3 meters
- Total---- 7 cores
- 52 meters

After a long uncored interval, nannofossil chalk oozes 57 meters thick were penetrated before the basalt basement was reached. These oozes were divided into three units. The top unit is a yellowish-brown marly chalk ooze, with only traces of foraminifers. This unit can be identified as the Endeavor Ooze, having a lithological character somewhat intermediate between that found at Site 15 and Site 17. The middle unit is recognized on the basis of a decrease in non-carbonate impurities. Foraminifera are present, but still rare. These oozes are very pale brown to light yellowish-brown in color, somewhat darker than a typical Fram Ooze. The bottom unit was recognized on the basis of the relatively large foraminifera content. The authors correlated this foraminiferal unit with those at Sites 14, 15, and 17 as a part of the Grampus Unit. The dark gray basalt is weathered a buff brown. A chilled glassy top can be observed. Coarsely crystalline calcareous sediments are erclosed in fractures which may represent recrystallized sediments entrapped in a basalt flow.

Calcareous sediments nannofossil rich.



SITE 18 LEG 3



SITE DATA

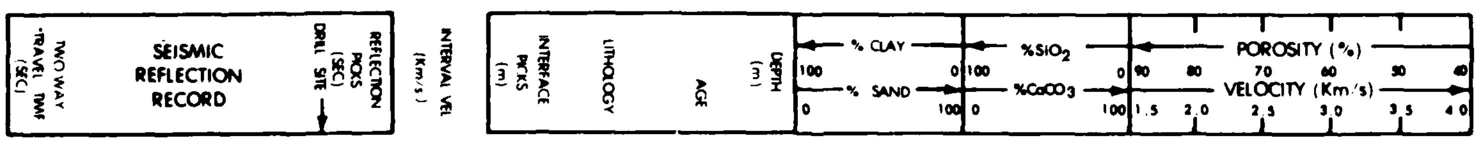
Position:
Latitude 28°32.1' S
Longitude 23°40.6' W
Date: 1/07/69
Time:
Water depth: 4677 meters
Location: Magnetic Anomaly 21

CORE DATA

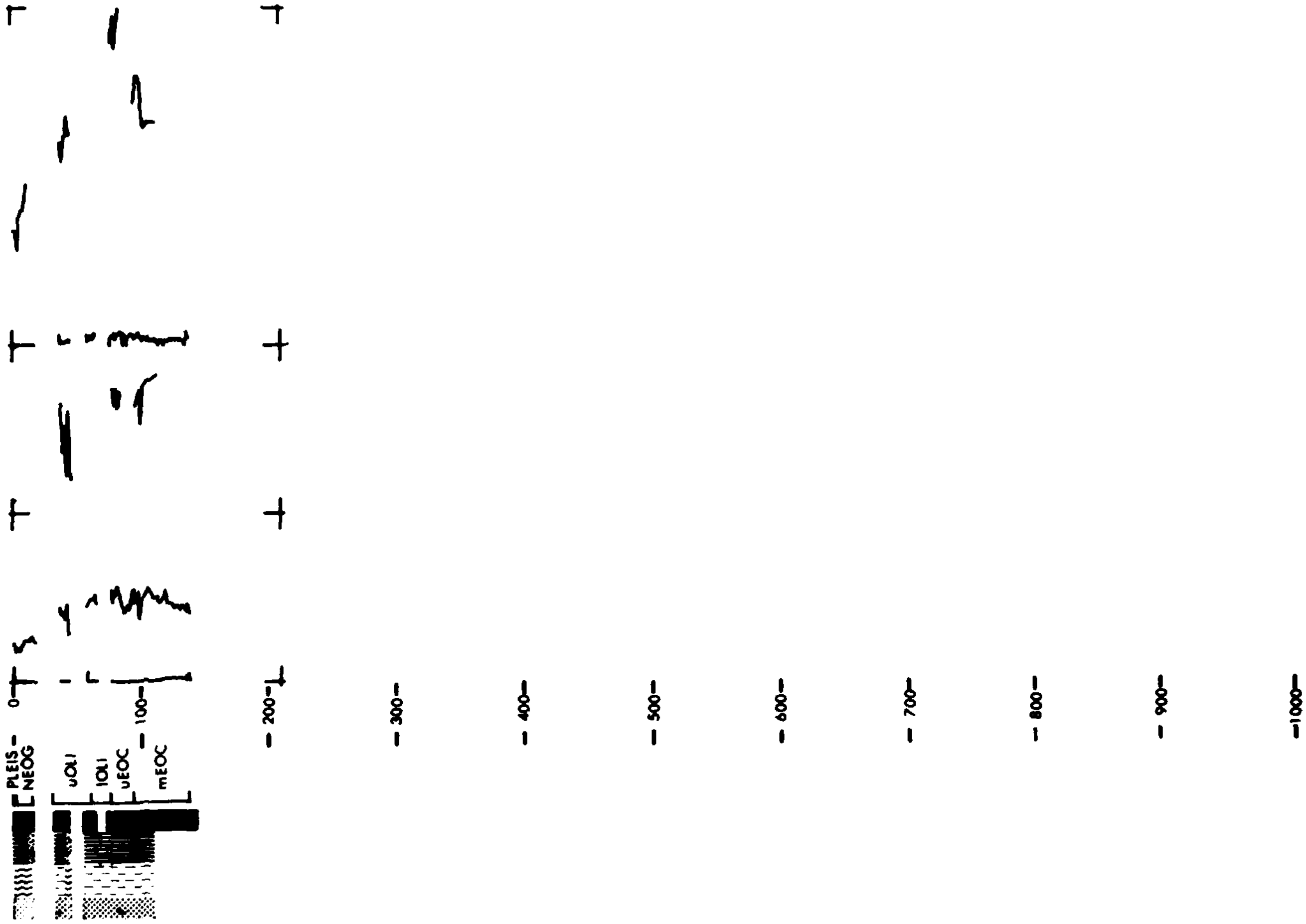
Penetration:
Drilled-- 42 meters
Cored---- 104 meters
Total---- 145 meters
Recovery:
Basement- 2 cores
2.1 meters
Total---- 12 cores
96 meters

The top unit is a local facies of a thin late Cenozoic brown nannofossil clay veneer which is present on the lower flanks of the Mid-Atlantic Ridge. Such veneers of late Cenozoic sediments are obviously the time-stratigraphic equivalents, in regions below the carbonate-compensation depths, of the Albatross, Blake and possibly Challenger Oozes. The Discovery Clay unit consists of zeolitic red clays. Intercalated within the Endeavor Ooze is the Braarudosphaerea Chalk Subunit, serving as a middle Oligocene time marker. Below the Endeavor Ooze is a sequence of nannofossil chalk and marl oozes. The upper oozes, relatively homogenous in lithology, are obviously a correlative of the Fram Ooze. The lower foraminiferal oozes, have all the characters of the Grampus Ooze. However, the interbedded chalk and marl oozes in the middle are sufficiently different from both. This middle interval should be separated as a unit to be correlated as the Gazelle Formation. Directly underlying the Grampus Ooze is the basalt basement. This basalt is definitely an extrusive flow.

Interbedded calcareous; nannofossil rich, and detrital sediments.



SITE 19 LEG 3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PLEIS-NEOG
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lOLI
uEOC
mEOC

SITE DATA

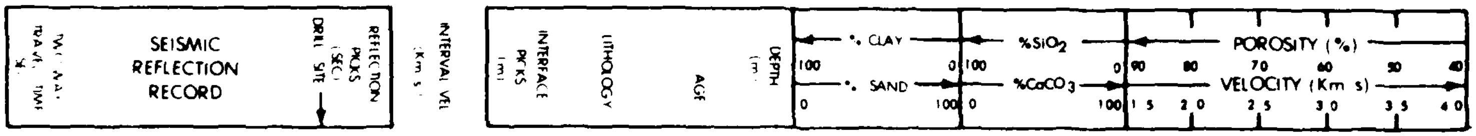
Position:
Latitude 28°32.1' S
Longitude 26°50.6' W
Date: 1 /10/69
Time:
Water depth: 4500 meters
Location: Magnetic Anomaly 30

CORE DATA

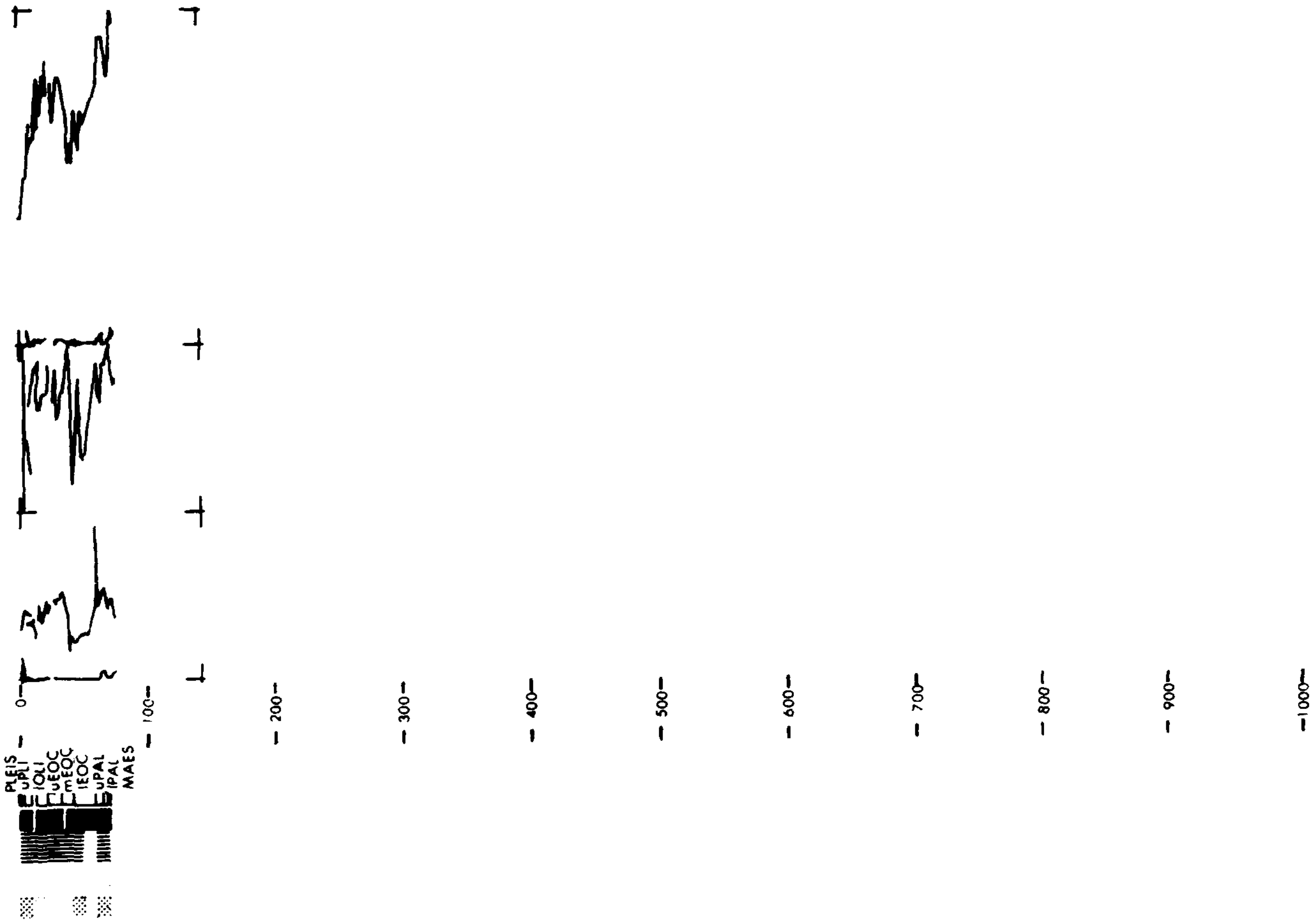
Penetration:	20	20A	20B	20C	
Drilled--	0	40	6	22	meters
Cored----	6.4	25	9	50	meters
Total----	6.4	65	15	72	meters
Recovery:					
Basement-	0	1	0	1	cores
	0	.4	0	.3	meters
Total----	1	4	2	6	cores
	6.1	11	9	48	meters

A normal oceanic sedimentary sequence was penetrated. This sequence could be divided into seven lithologic units, of which five constitute formations: Local Unit, brown foraminiferal marl ooze, with manganese nodules; Local Unit, nannofossil marl ooze; Discovery Clay, red clays and nannofossil chalk oozes; Endeavor Ooze, nannofossil marl oozes and clays, including the Braarudosphaera Chalk Subunit; Fram Ooze, nannofossil chalk oozes; Gazelle Ooze, zeolitic marl oozes and clays; and the Hirondelle Ooze, nannofossil chalk oozes, foraminiferal at it's base. The basalt is a pillow breccia and, thus, definitely an extrusive. Fragments of black glass and aphanitic basalt, now weathered, are mixed in a marble matrix.

From upper Oligocene to lower Paleocene sediments nannofossil rich.



SITE 20 LEG 3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SITE DATA

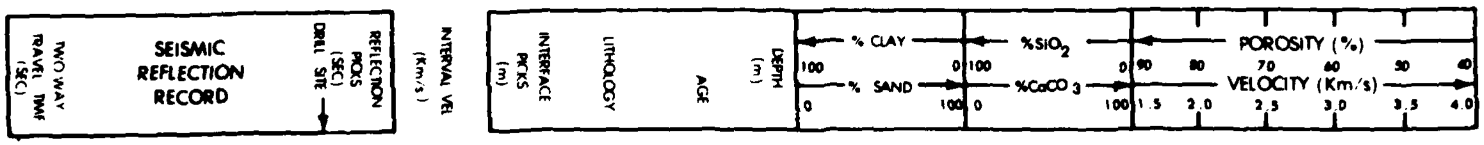
Position:
Latitude 28 o 35.1' S
Longitude 30 o 35.8 W
Date: 1/15/69
Time:
Water depth: 2113 meters
Location: Edge of the Rio Grande Rise

CORE DATA

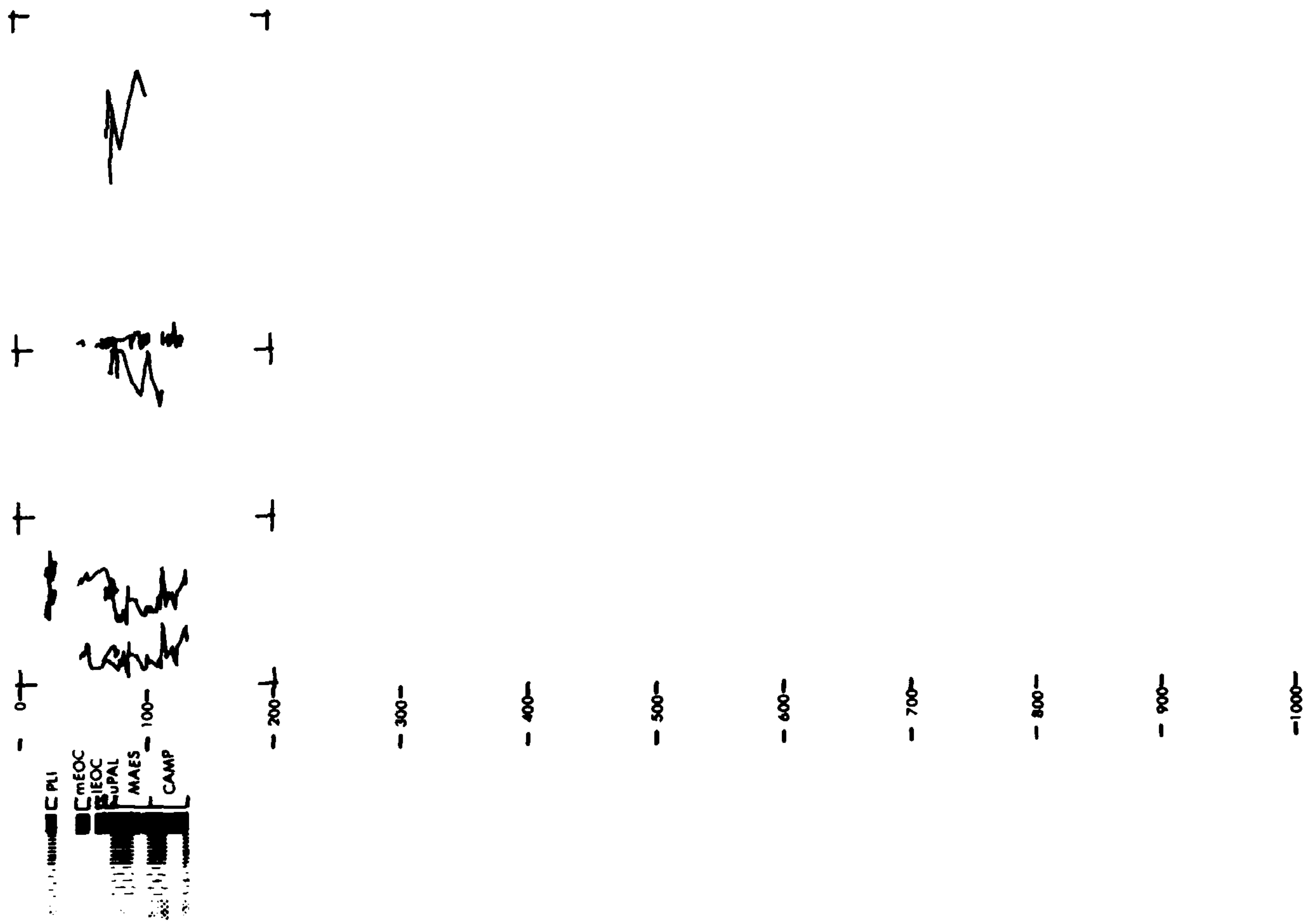
	21	21A	
Penetration:			
Drilled--	60	52	meters
Cored----	71	28	meters
Total---	131	79	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	9	3	cores
	72	27	meters

The sedimentary section of Site 21 is, on the whole, more foraminiferal and less terrigenous than those on the blanks of the Mid-Atlantic Ridge. The sediments of the top unit (Albatross) consist mainly of calcareous planktons. After a short uncored interval, Eocene nannofossil chalk oozes were encountered. The Pliocene, Miocene, and Oligocene sediments are absent. A sequence of white, very pale brown and pink chalk oozes, with dolomite chalk oozes that have been sufficiently lithified to constitute an acoustic reflector, was grouped together. The authors have correlated it with the basal sedimentary unit at Site 20 as the Hirondelle Ooze Formation. The 3rd unit consists of pink, foraminiferal nannofossil chalk oozes, characterized by the presence of Inoceramus fragments. The 4th unit is a white to grayish-white foraminiferal nannofossil chalk ooze. The lowest sample cored at Site 21 is a coquina rock. The rock is porous well-sorted biosparite. The top of this hard coquina layer could be identified as the "basement reflector" at Site 21.

Pliocene sediments foraminifera rich. Upper Paleocene to Campanian nannofossil rich.



SITE 21 LEG 3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SITE DATA

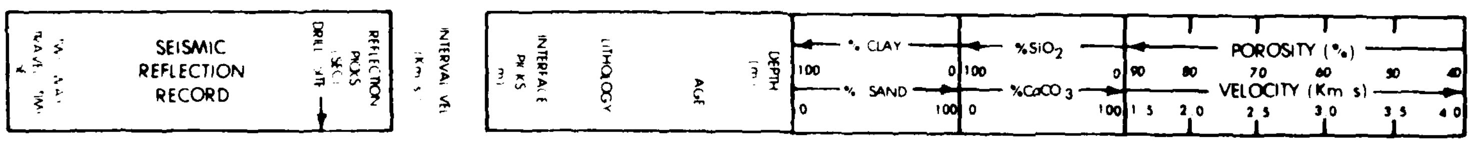
Position:
  Latitude $30^{\circ}00.3'$ S
  Longitude $35^{\circ}15.0'$ W
Date: 1 /18/69
Time:
Water depth: 2134 meters
Location: Rio Grande Rise

CORE DATA

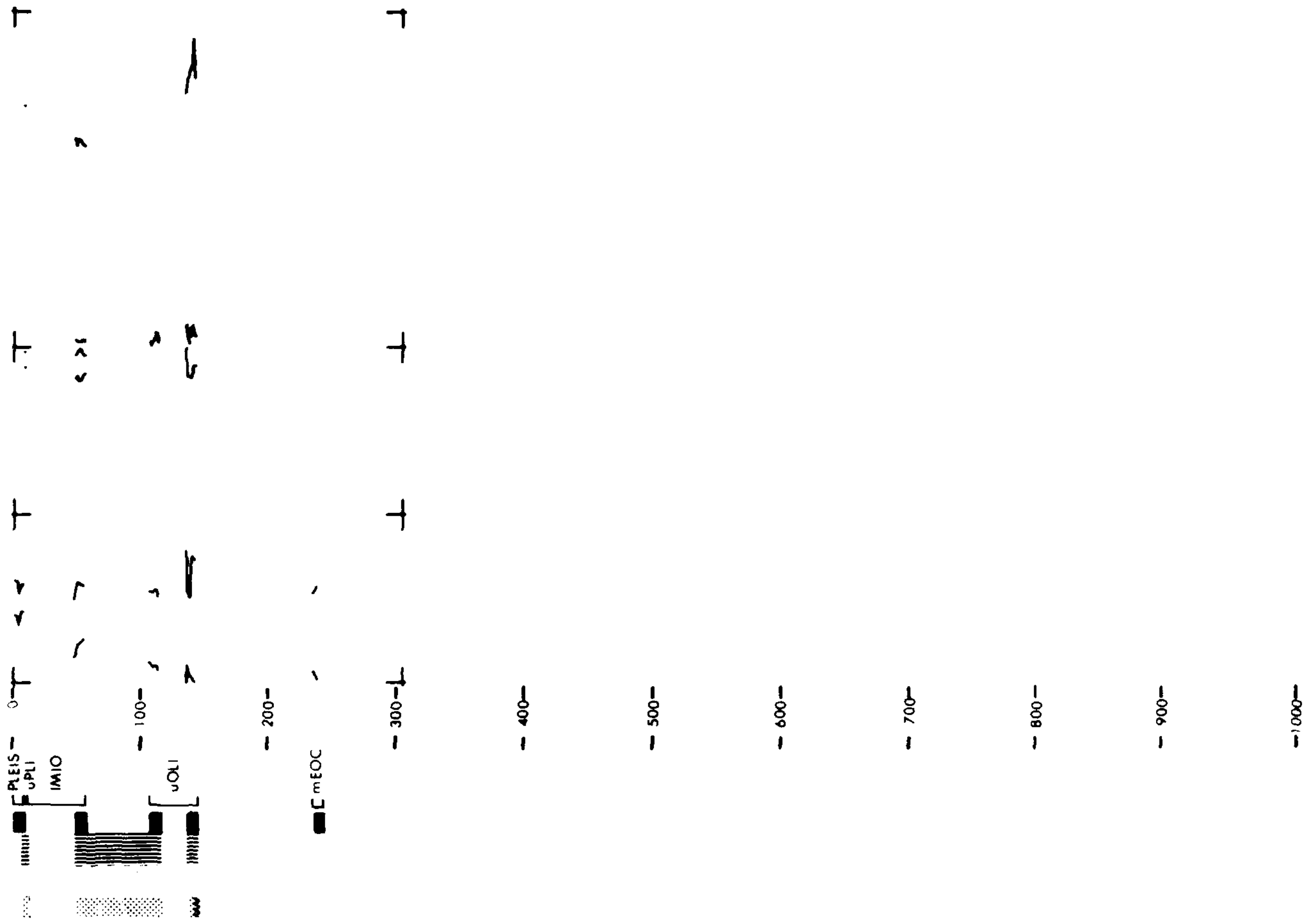
Penetration:
  Drilled-- 198 meters
  Cored---- 44 meters
  Total---- 242 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 5 cores
  38 meters

The first unit, pale brown chalk oozes, can be identified as the Albatross Ooze. The 2nd unit underlies the Albatross Ooze disconformably. Lower Miocene and Upper Oligocene are pink chalk oozes. The lowest Upper Oligocene chalk oozes cored include less than 1 per cent foraminifera and are, thus, lithologically very similar to the Oligocene Fram Ooze of the Mid-Atlantic Ridge province. Included in this unit is the widespread Braarudosphaera Chalk. The Tertiary sediments at Site 22 are similar to those at the adjacent Rio Grande Rise site (Site 21) in several aspects: (1) the common presence of foraminifera, which are especially abundant in the Quaternary, and (2) the absence of marl oozes and red clays. Middle Eocene section has been cored at both sites, and the cherty carbonate rock at Site 22 could be correlated with the dolomitic chalk at Site 21 as the acoustic reflector RGR-2 (Rio Grande Rise, No. 2). Yet, the thick Oligocene-Miocene section at Site 22 is absent at Site 21, where a much thicker Quaternary section is present.

Sediments nannofossil rich. One thin layer foramimifera rich, occurs in lower Miocene time.



SITE 22 LEG 3



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SITE DATA

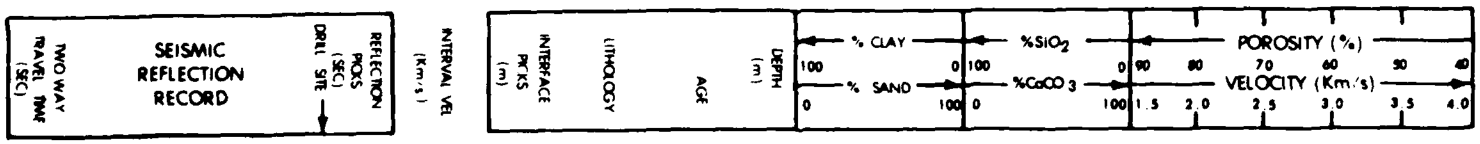
Position:
Latitude 6°08.7′ S
Longitude 31°02.6′ W
Date: 2 / 01/ 69
Time:
Water depth: 5079 meters
Location: Pernambuco Abyssal Plain

CORE DATA

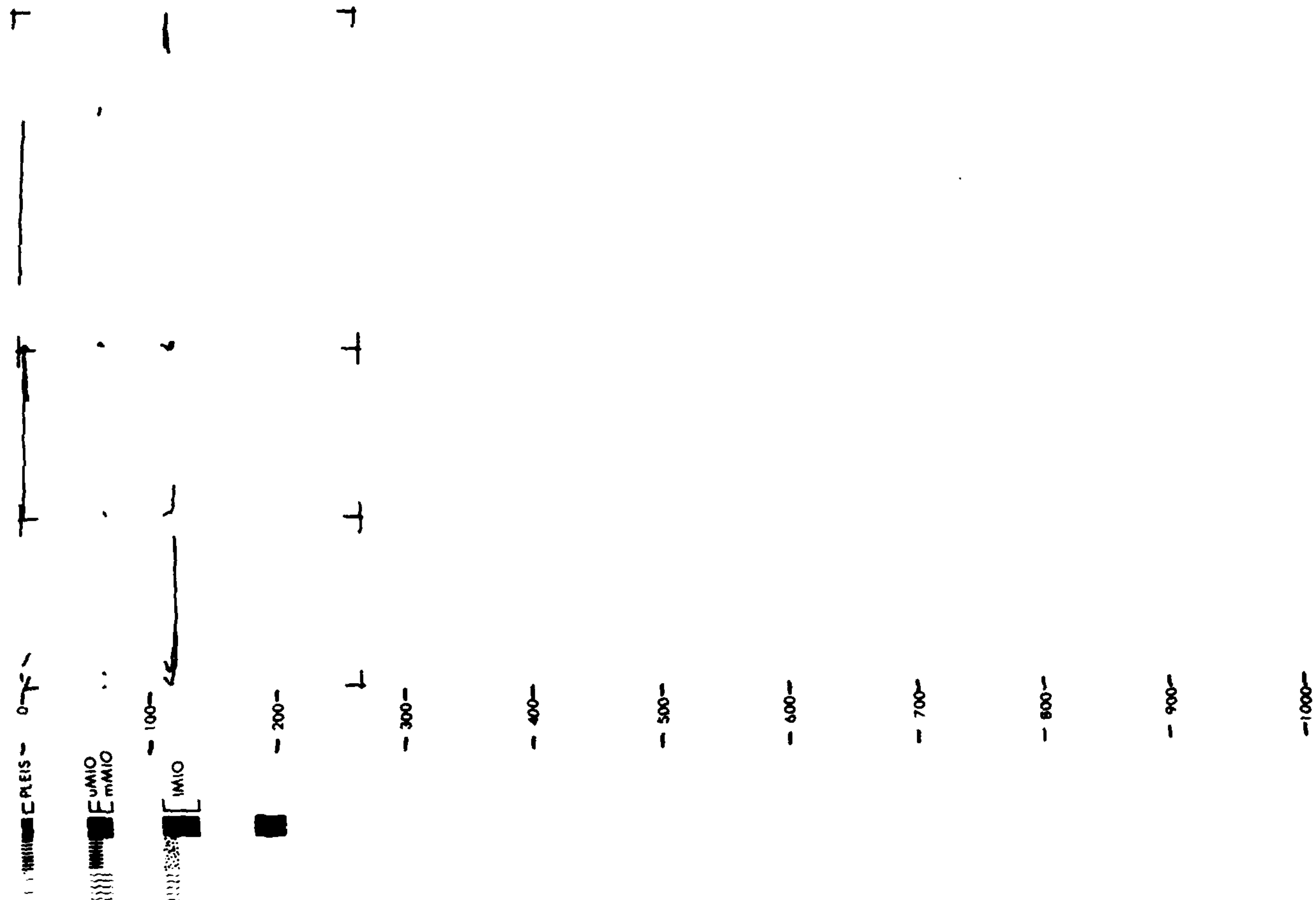
Penetration:
Drilled-- 136 meters
Cored---- 72 meters
Total---- 208 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 9 cores
23 meters

The Pleistocene sediments must consitute a thin veneer. Cores 2 and 3, taken between 53.3 and 71.6 meters below the sea floor recovered more typical deep sea "red clay". The clay is actually yellowish-brown, and contains zeolites, but is almost completely devoid of calcareous fossils. Cores 4, 5, and 6 were taken between 112.5 and 139.9 meters below the sea floor, starting just above the predicted depth of Horizon A. These recovered sandy turbidites with quartz and calcareous fossils, including some larger shallower water foraminifera, interbedded with greenish-gray silty clays virtually devoid of calcareous fossils. Planktonic foraminifera and calcareous nannofossils are abundant but sometimes poorly preserved in the sandy turbidite layers, and indicate an age of early Early Miocene. The basalt contains coarse plagioclase crystals and finer laths of plagioclase as well as altered pyroxene (Titan-augite). Saponite (?) is an abundant secondary mineral. The basalt is heavily altered, and much of the texture has been destroyed. The texture appears to be diabasic or porphyritic. Several of the larger basalt fragments exhibit steeply dipping banding.

Pleistocene calcareous sediments foraminifera rich.



SITE 23 LEG 4



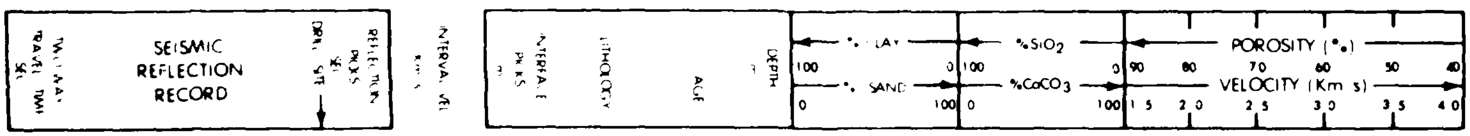
SITE DATA

Position:
Latitude $6^{\circ}16.3'$ S
Longitude $30^{\circ}53.5'$ W
Date: 2/05/69
Time:
Water depth: 5148 meters
Location: Pernambuco Abyssal Plain

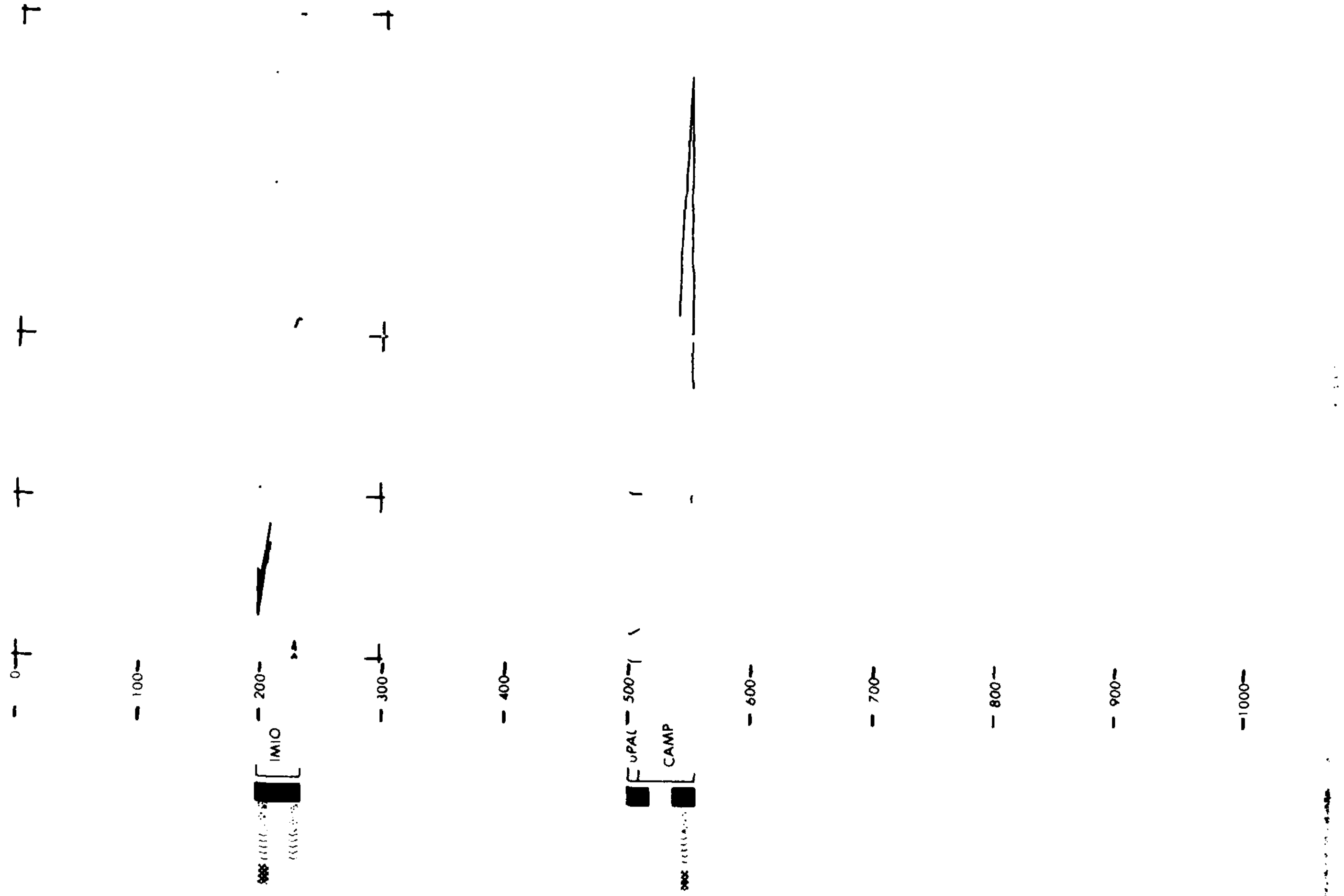
CORE DATA

Penetration:	24	24A	
Drilled--	197	523	meters
Cored----	37	35	meters
Total----	234	558	meters
Recovery:			
Basement-	0	1	cores
	0	.03	meters
Total----	4	4	cores
	5	3.3	meters

The sediments cored in both holes resemble geosynclinal "flysch"-type deposits suggesting that flysch beds can be deposited in very deep water. These sediments have an aggregate thickness of more than 350 meters and can be assumed to be widely distributed over at least the western part of the Pernambuco Basin. They must represent the erosion of a land mass of considerable size. The upper zone from 198.1 to 234.7 meters is compacted clay interbedded with relatively thin beds of medium- to fine-grained sand turbidites. The top of the lower cored zone consists of compacted mudstone that is locally indurated and contains up to 20 per cent terrigenous detritals plus a small radiolarian fauna. The hole was bottomed in olivine basalt. The material below the basalt fragments was a dark brown fluid mud with fragments of the mudstone greywacke; the authors interpret it as hiving been drawn into the core barrel after the coring had been completed. The basalt is much finer-grained than that cored in Site 23. It has a microcrystalline groundmass, some of which may be altered glass, that has been extensively altered hydrothermally.



SITE 24 LEG 4



SITE DATA

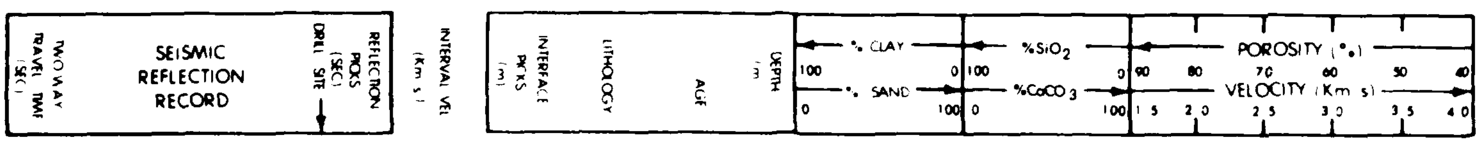
Position:
Latitude 0°31.0'S
Longitude 39°14.4'W
Date: 2/08/69
Time:
Water depth: 1916 meters
Location: North Brazilian Ridge

CORE DATA

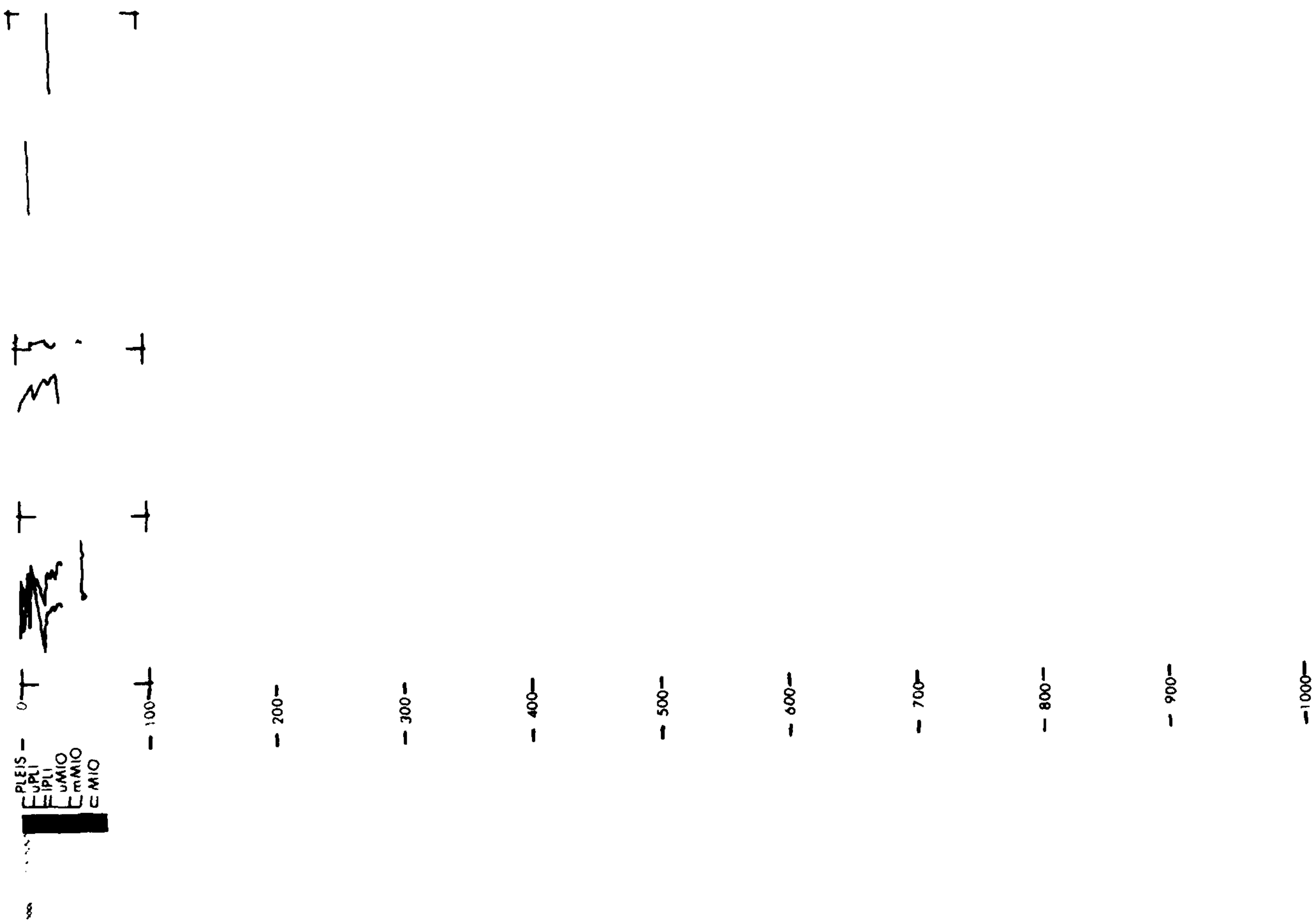
Penetration:	25	25A	
Drilled--	2	57	meters
Cored----	64	20	meters
Total----	66	77	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	9	3	cores
	25	2.7	meters

The lower Pleistocene and upper Pliocene oozes contain up to 10 per cent clay minerals and silt-size detritals; in all other parts of the section, detritals make up only one or two percent of the deposits. At 45.7 meters the drill penetrated a harder bed. The limestone fragments are of several colors and are sub-angular to sub-round. At least one of the small pebbles is a "conglomerate", consisting of sandstone-size fragments of limestone cemented by white calcium carbonate. The small sample of gravel is obviously the result of erosion and redeposition of the underlying limestone under shallow water conditions. The drill, after penetrating one hard layer from 45.7 to 47.2 meters went through alternating harder and softer beds that may well have been sand and gravel. No core was recovered from 54.9 to 59.4 meters but the core catcher had one large piece of fragmental limestone. The piece consists of algae, fragments of shells and byrozoa, plus pieces of white limestone, pyrite specular hematite and limonite. It is similar in appearance to certain types of modern reef limestone. Some of the matrix is recrystallized. This, plus the limonite, suggests that the sample has been weathered subaerially.

Pleistocene and upper Pliocene sediments foraminifera rich.



SITE 25 LEG 4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SITE DATA

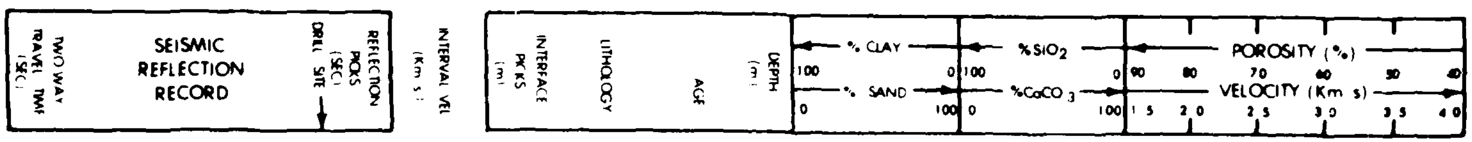
Position:
Latitude 10°53.5'N
Longitude 44°02.6'W
Date: 2/14/69
Time:
Water depth: 5169 meters
Location: Mid-Atlantic Ridge

CORE DATA

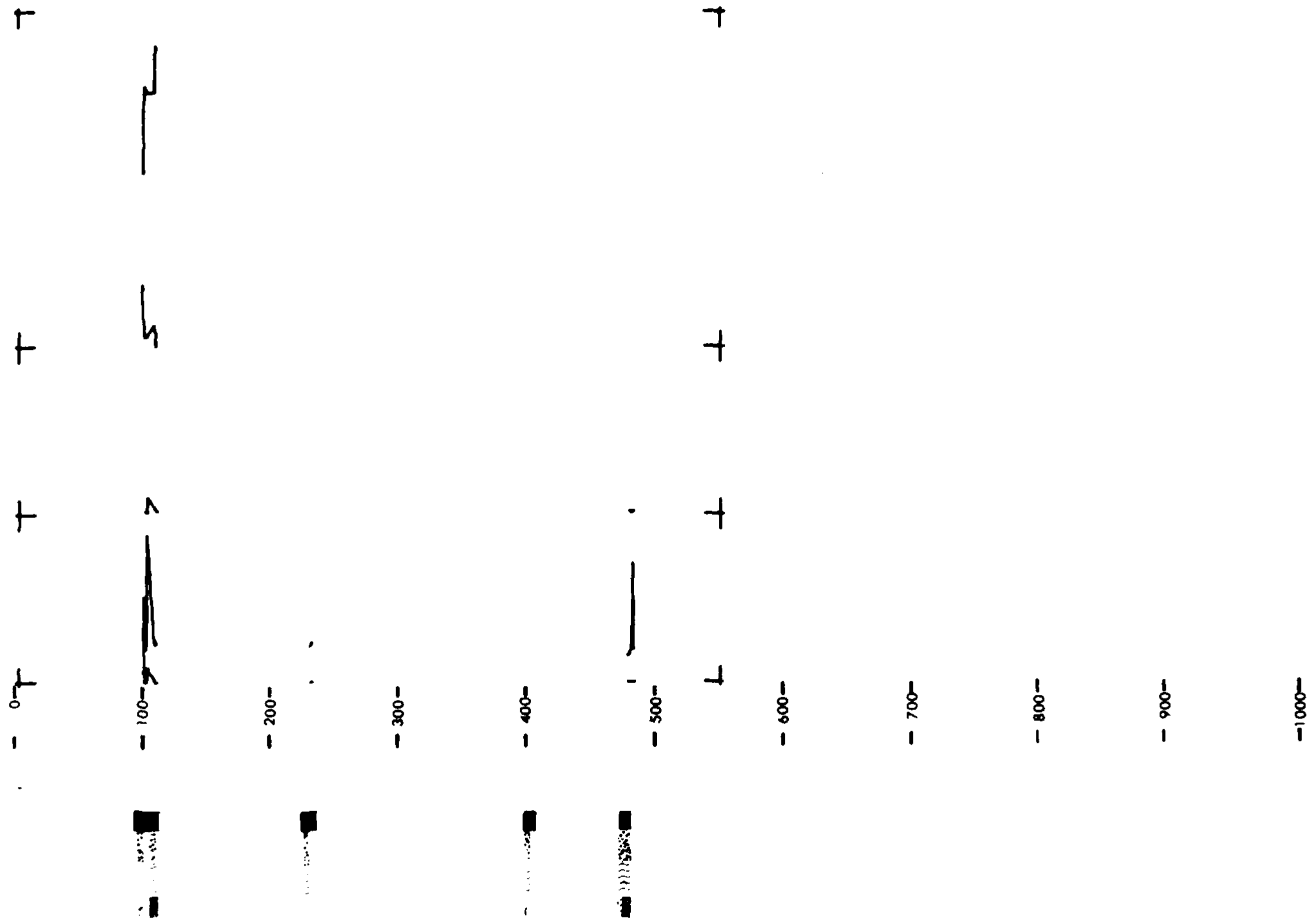
Penetration:	26	26A	
Drilled--	0	440	meters
Cored----	9	43	meters
Total----	9	483	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	5	cores
	0	14	meters

The total sequence appears to consist of turbidity deposits. A small number of grains are fragments of schist. It is noteworthy that, except for one questionable grain of olivine, none of the sediments seem to be derived from the adjacent scarps of the fracture zone. The hematitic quartz, rose quartz, beryl and corundum suggest an Amazon provenance. Material of organic origin is present in all sand beds. In some the organic fraction consist largely of foraminifera; but in others, especially those with coarser grain size, the foraminifera are eclipsed by large volumes of organic "trash". This material is mostly plant remains. The pebbles are micaceous siltstone and sandstone, light-gray, pink and orange-red in color. A few of the larger sandstone pebbles contain Pleistocene foraminifera. The pebbles might be fragments of lithified beds, rounded by the drilling, but they are quite abundant, very well rounded and of various sizes down to that of coarse sand. More likely they are derived from erosion of Pleistocene beds of the Amazon delta on the continental shelf. The erosion may have been submarine turbidity currents or may have been by streams during a glacial stage when sea level was lowered.

Detrital sediment; occasionally mica rich.



SITE 26 LEG 4



SITE DATA

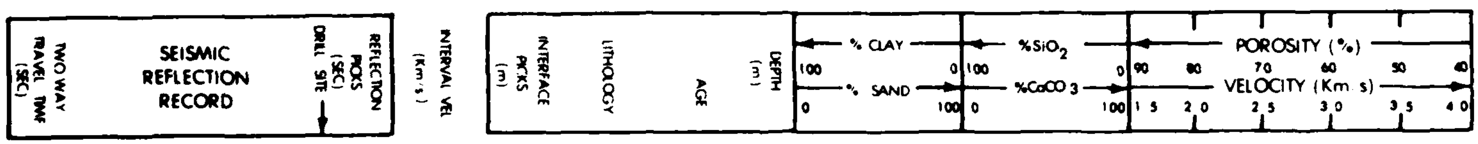
Position:
Latitude 15°51.4' N
Longitude 56°52.8' W
Date: 2 / 23/ 69
Time:
Water depth: 5251 meters
Location: Demerara Abyssal Plain

CORE DATA

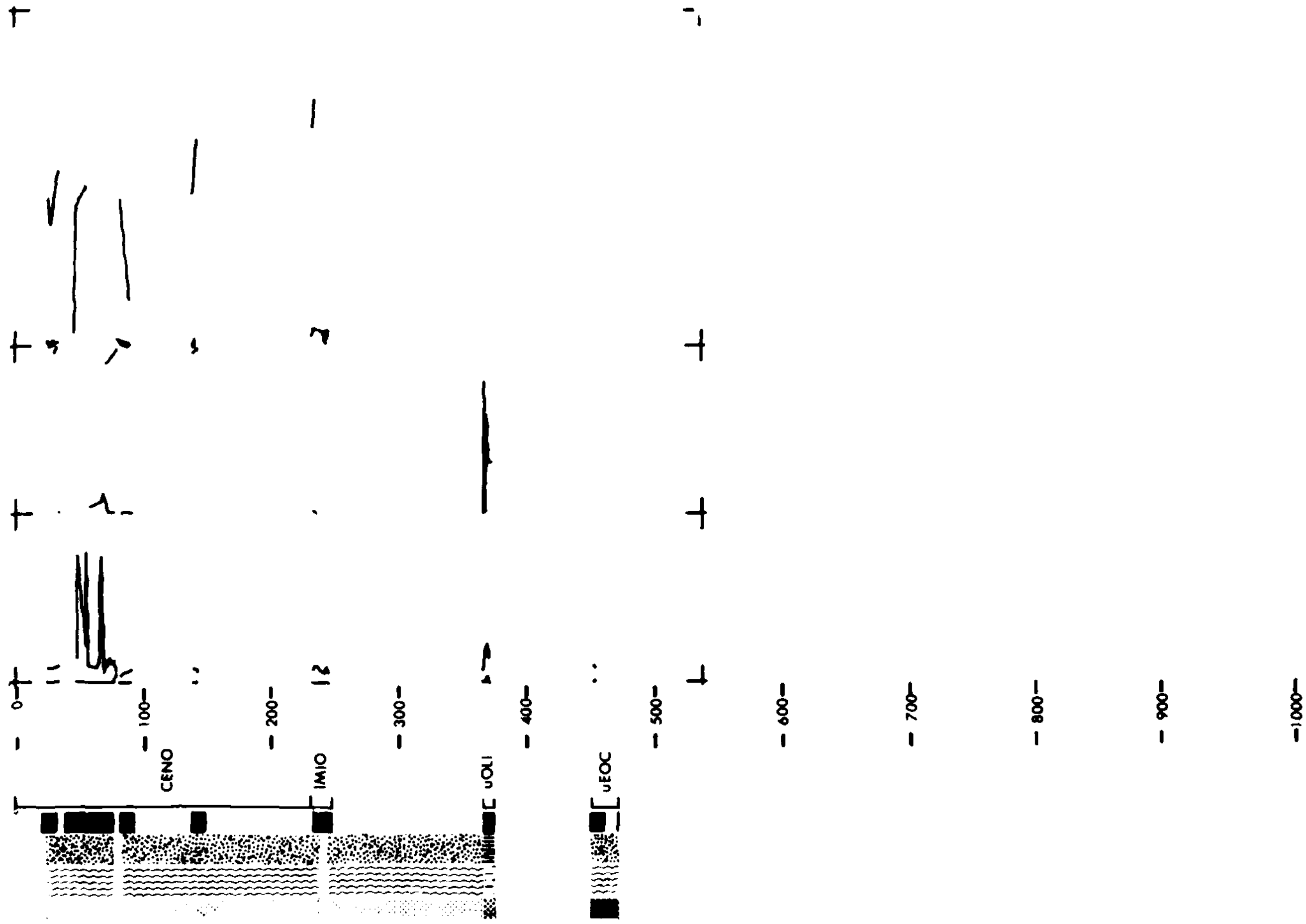
Penetration:	27	27A	
Drilled--	419	35	meters
Cored----	56	46	meters
Total----	475	81	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	7	5	cores
	29	31	meters

The Pleistocene beds consist largely of grayish brown and brown plastic clays with some dolomite, very low silt content, and few fossils. Interbedded with the clay are occasional very thin stringers of medium gray fine sand, silt, and silty clay that are probably small turbidites. Between 67.1 and 70.1 meters are two turbidite beds, two to three feet thick. The olivine and possibly the pyroxene suggest a different source area from that which contributed the bulk of the sand. Beds of Miocene age consist largely of grayish-brown to olive-gray, silty to slightly sandy plastic clays with some glauconite and pyrite. At about 236.2 and 248.4 meters there are two turbidite beds, each about 10 centimeters thick, consisting of fine sandy silt grading upward into silty clay. Oligocene beds are probably deposited near the bottom of the zone of carbonate compensation; the foraminifera were dissolved, but the nannoplankton remained intact. The top of many Upper Eocene beds appear to be truncated by the base of the next overlying beds. Some of the thin beds show undulating cross-bedding suggestive of ripple marks. Deposition was near the bottom of the zone of carbonate compensation.

Upper Oligocene sediment; calcareous, nannofossil rich, interbedded with detrital sediment in a thin layer.



SITE 27 LEG 4



SITE DATA

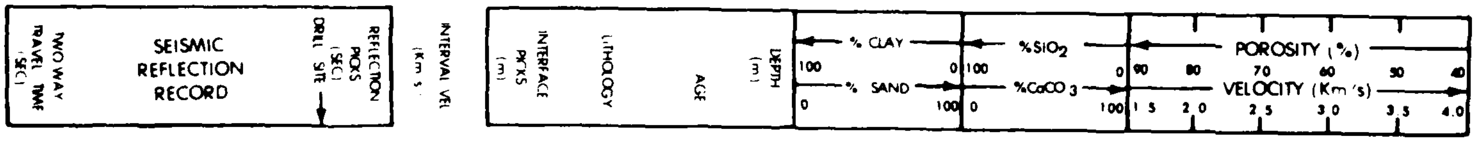
Position:
Latitude 20° 35.2' N
Longitude 65° 37.3' W
Date: 3/03/69
Time:
Water depth: 5251 meters
Location: Outer Ridge

CORE DATA

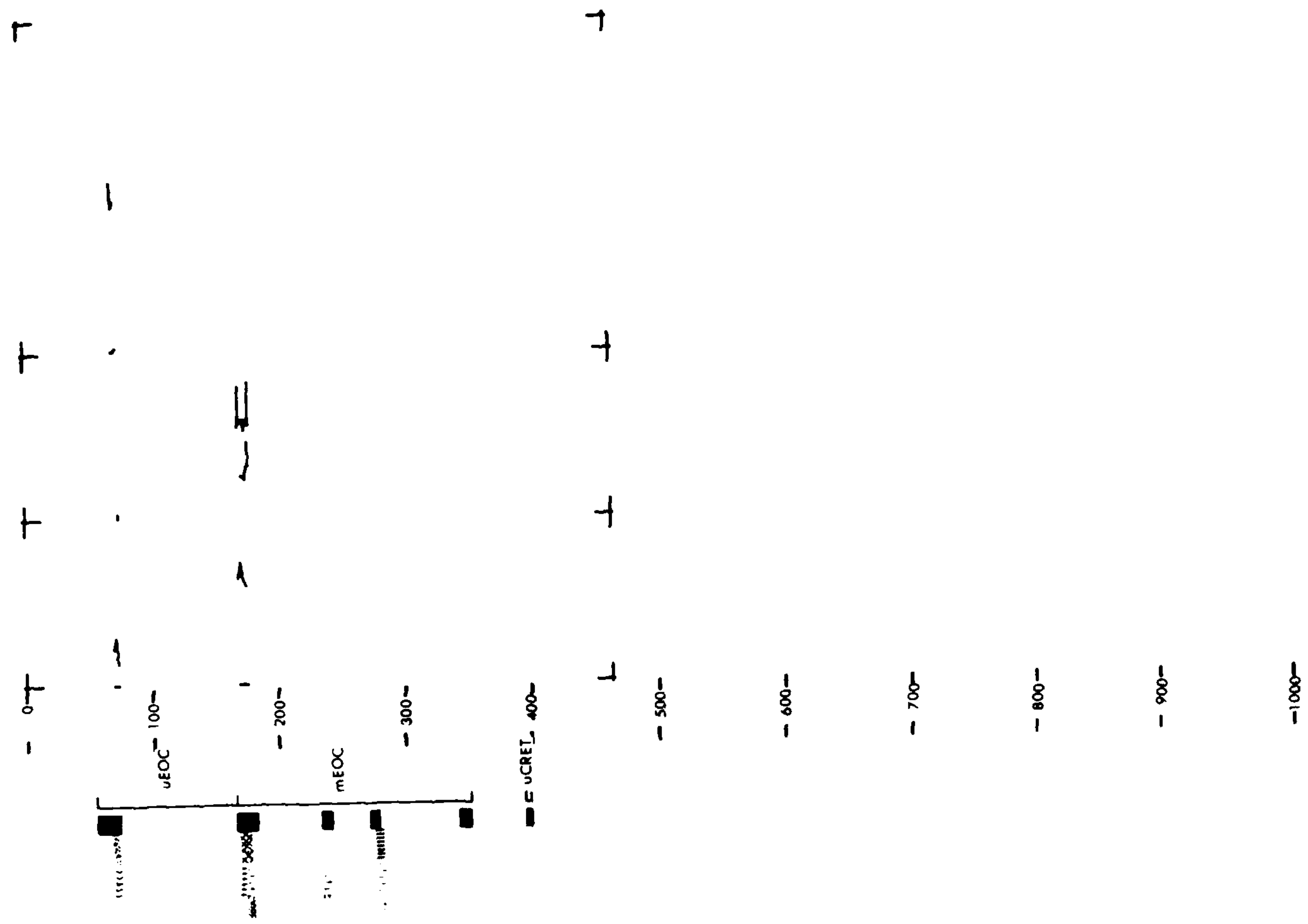
Penetration:
Drilled-- 339 meters
Cored---- 65 meters
Total---- 404 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 9 cores
14 meters

Coring began at a depth of 59 meters below the sea floor. The sediments are deep sea "red clays". In cores 3 and 4 the carbonate content seems to decrease with depth with an increase in the amount of clay and siliceous fossils. The calcareous nannofossils and Radiolaria suggest an age of late Middle Eocene for these strata. At 176 meters is a thin bed of hard, indurated white siliceous limestone. No samples were taken between 185 and 236 meters where a hard layer impeded drilling progress, and consisted of white, friable chalky material, highly calcareous. Recovered from 245 to 275 meters was gray clay, constituting about 65% of the sample; "chert-like" hard fragments of argillite, non-calcareous; and, white chalky claystone, friable and highly calcareous. Cores 7 and 8 contained calcareous clay. After hitting another hard layer at 400 meters Core 9 attempted to core the sediment below. Only about 30 cc of sediment were recovered, consisting of greenish-gray clay, noncalcareous.

Upper Eocene sediments; siliceous, rarely diatom rich. Middle Eocene sediment; calcareous, nannofossil rich.



SITE 28 LEG 4



SITE DATA

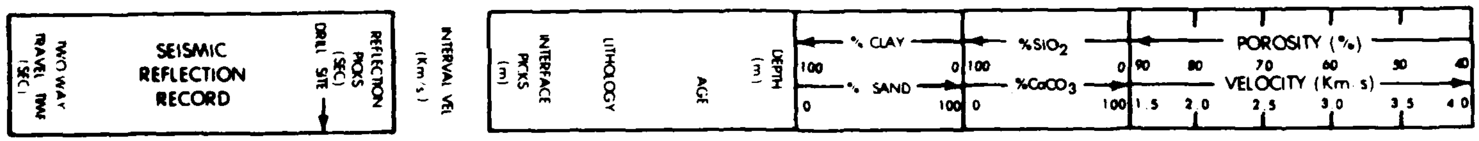
Position:
Latitude 14°47.1'N
Longitude 69°19.4'W
Date: 3/09/69
Time:
Water depth: 4247 meters
Location: Venezuelan Basis

CORE DATA

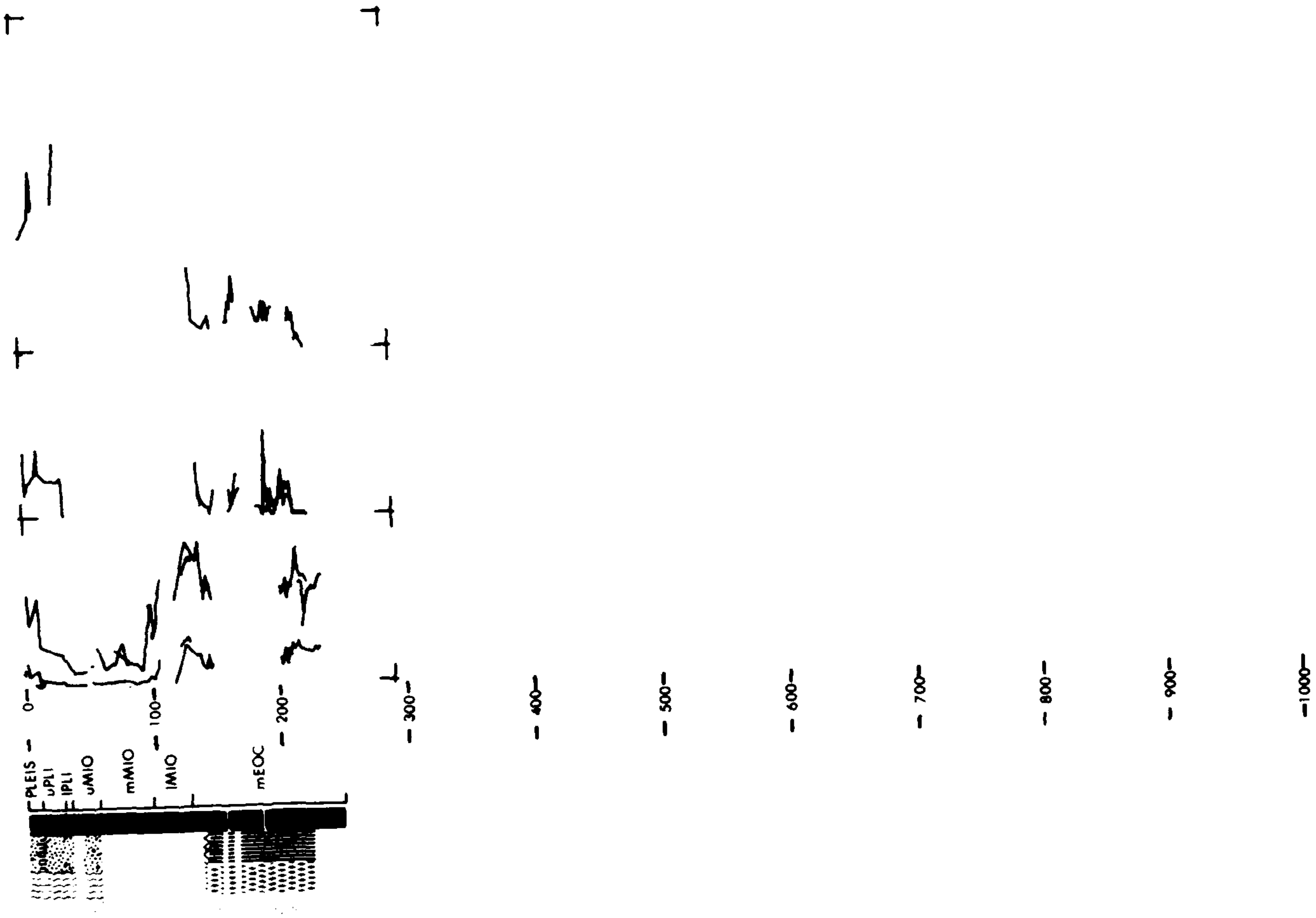
	29	29 A	29 B	29 C	
Penetration:					
Drilled--	65	40	145	230	meters
Cored----	165	46	86	18	meters
Total----	230	86	231	248	meters
Recovery:					
Basement-	0	0	0	0	cores
	0	0	0	0	meters
Total----	20	5	10	3	cores
	86	3.4	52	1.4	meters

Core 1, a core of the surficial sediment, recovered a sequence of 9.1 meters of beige to yellow-brown calcareous plankton ooze. Cores 3 through 6 sampled the interval between 60.4 and 96.6 meters and the sediments are gray to beige mottled plastic foraminiferal marls. The upper soft, light gray marl ooze is underlain by a moderately hard, dark-gray silty clay containing minor amounts of mica, zeolites and non-skeletal carbonate. Core 8 contains a firm, light to dark gray, or beige to green calcareous nannofossil chalk, with up to 80 per cent calcareous nannoplankton fossils, the rest of the sediment being planktonic foraminifera and clay. This is interbedded with a nannoplankton marl. Cores 9 and 10 were indurated, compact calcareous nannoplankton chalk. This material is indurated, and the sections were split with difficulty. Only a few sections of this harder material were split on board ship, and they show no distinct bedding or structures other than burrows which give the chalk a streaky and mottled character. Calcareous plankton date this material as Early Miocene. From the base of the hole was a sample of pink-to-reddish firm clay.

Pleistocene calcareous sediments, lower Miocene and middle Eocene sediments nannofossil rich.



SITE 29 LEG 4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SITE DATA

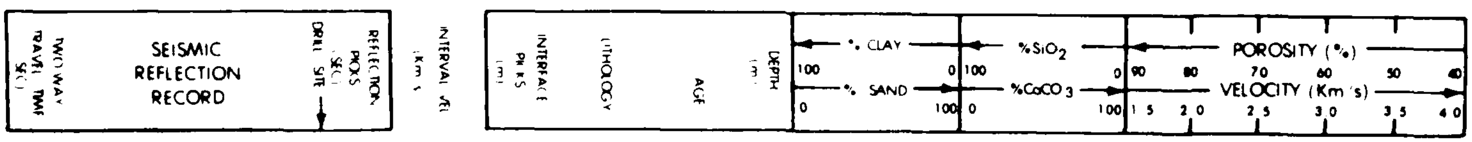
Position:
Latitude 12°52.9' N
Longitude 63°23.0' W
Date: 3/16/69
Time:
Water depth: 1218 meters
Location: Aves Ridge

CORE DATA

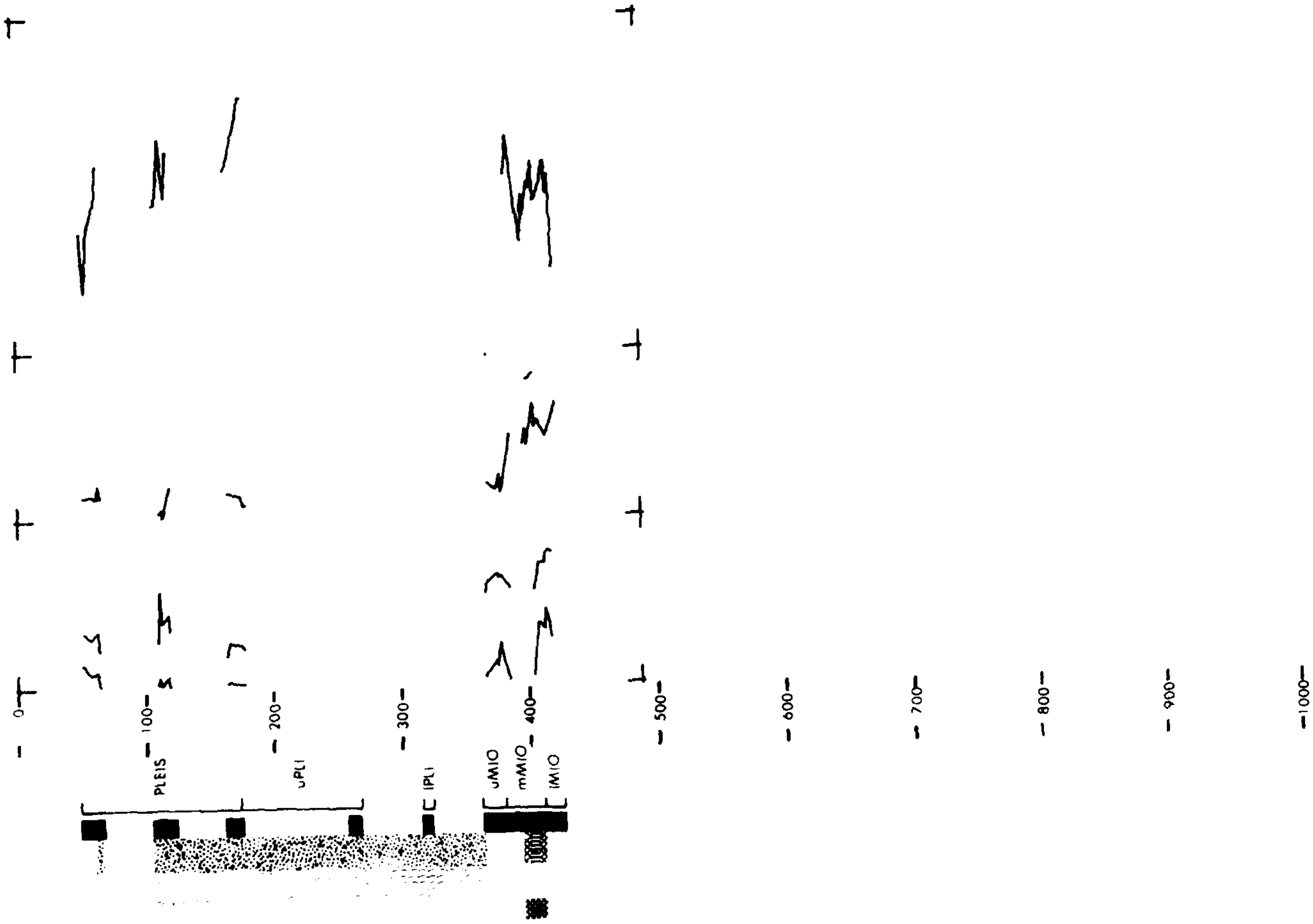
Penetration:
Drilled-- 297 meters
Cored---- 133 meters
Total---- 430 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 16 cores
62 meters

After drilling through the surficial sediments, coring was started at a depth of 50.3 meters. The sediment recovered are green-gray calcareous clays, and the cores are very fluid, with some sections essentially liquid. There are a few layers of fine foraminiferal ooze, but these cores are highly disturbed by the coring process. The calcareous nannoplankton and planktonic foraminifera indicate a Late Pleistocene age. Cores 3 through 8 recovered green-gray soft silty calcareous clays. Cores 9 through 16 (365.8 and 430.1 meters) contain gray siltstones with up to 20 percent clay content. There are small amounts of volcanic ash in the fine sand fraction of these sediments, and unaltered feldspars are present along with finely disseminated glauconite grains. Many of these cores show extensive mottling produced by burrowing organisms; some of the markings are quite distinctive. These deeper strata are somewhat indurated, and were usually split with a saw. Calcareous plankton are generally abundant, but the preservation of the nannofossils is often poor. Cores 9 through 16 represent the Middle and late Early Miocene.

Miocene sediments foraminifera rich.



SITE 30 LEG 4



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SITE DATA

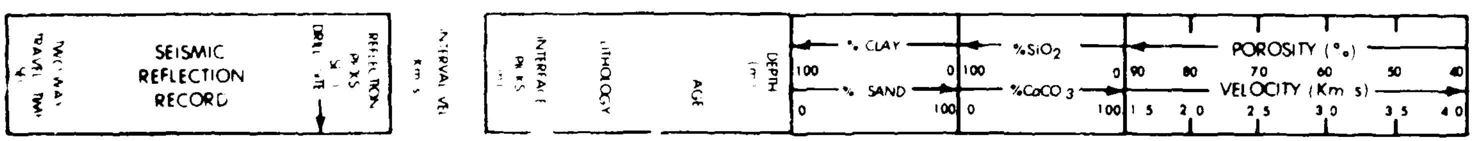
Position:
    Latitude   14°56.6' N
    Longitude 72°01.6' W
Date: 3/19/69
Time:
Water depth: 3369 meters
Location: Beata Ridge

CORE DATA

Penetration:
    Drilled-- 188 meters
    Cored---- 91 meters
    Total---- 279 meters
Recovery:
    Basement-   0 cores
                0 meters
    Total---- 10 cores
               41 meters

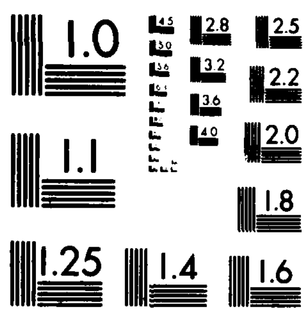
The Late Pleistocene is represented by the surficial deposits yellowish-gray to light olive gray soft silty clays with abundant planktonic foraminifera and calcareous nannofossils. The base of the Pleistocene is in Core 2 (Hole 29), and is closely associated with a change in the lithology of the sediment from olive-gray soft clays to olive-gray planktonic foraminiferal ooze. The change in lithology is gradual. From 37 to 94 meters are brown to olive soft clays devoid of calcareous and siliceous fossils. At the base is a soft-white clayey chalk with abundant calcareous nannofossils and planktonic foraminifera of Early Miocene age. Continuing, the sediment is brownish clay and white chalk ooze like that in the overlying core, and also of Early Miocene age. The radiolarian ooze is soft, friable, yellowish-brown to pale orange. It is mottled and banded, but remarkably homogeneous in composition. Three attempts were made to core the chert underlying the radiolarian ooze. No softer beds were recovered by these coring attempts, although it seems likely that the hard chert layers are interbedded with softer radiolarian ooze.

Pleistocene, upper Pliocene sediments and lower Miocene; foraminifera rich. Middle Miocene and upper Oligocene nannofossil rich.



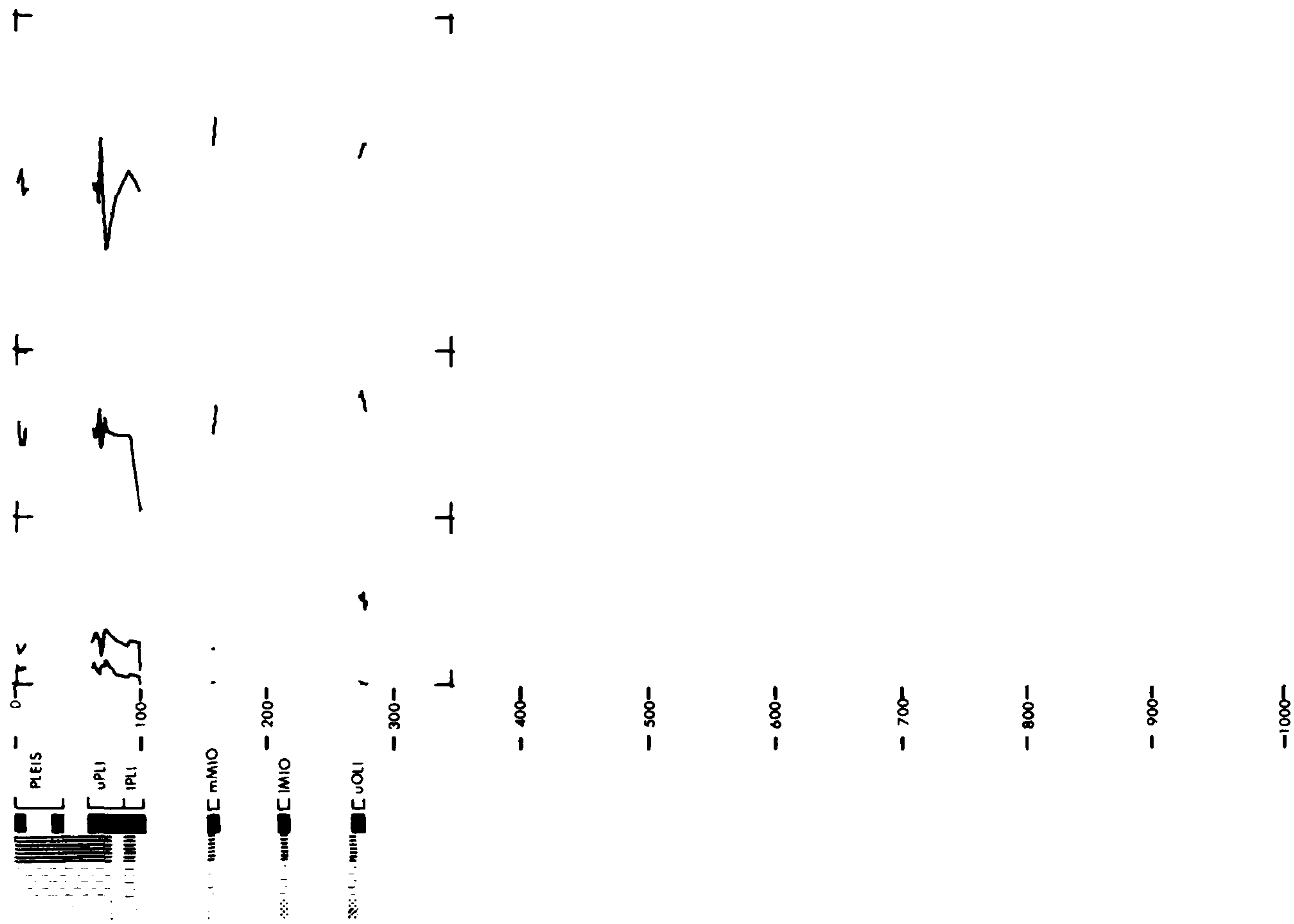
AD-A108 115 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 8/10
A SUMMARY OF SELECTED DATA: DSDP LEGS 1-19.(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL

2 of 5



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SITE 31 LEG 4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SITE DATA

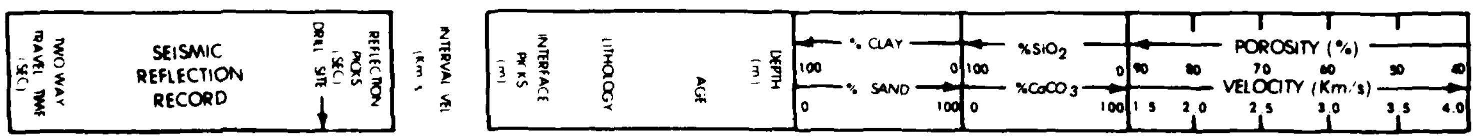
Position:
Latitude 37°07.6' N
Longitude 127°33.4' W
Date: 4/15/69
Time:
Water depth: 4758 meters
Location: Delgada Fan

CORE DATA

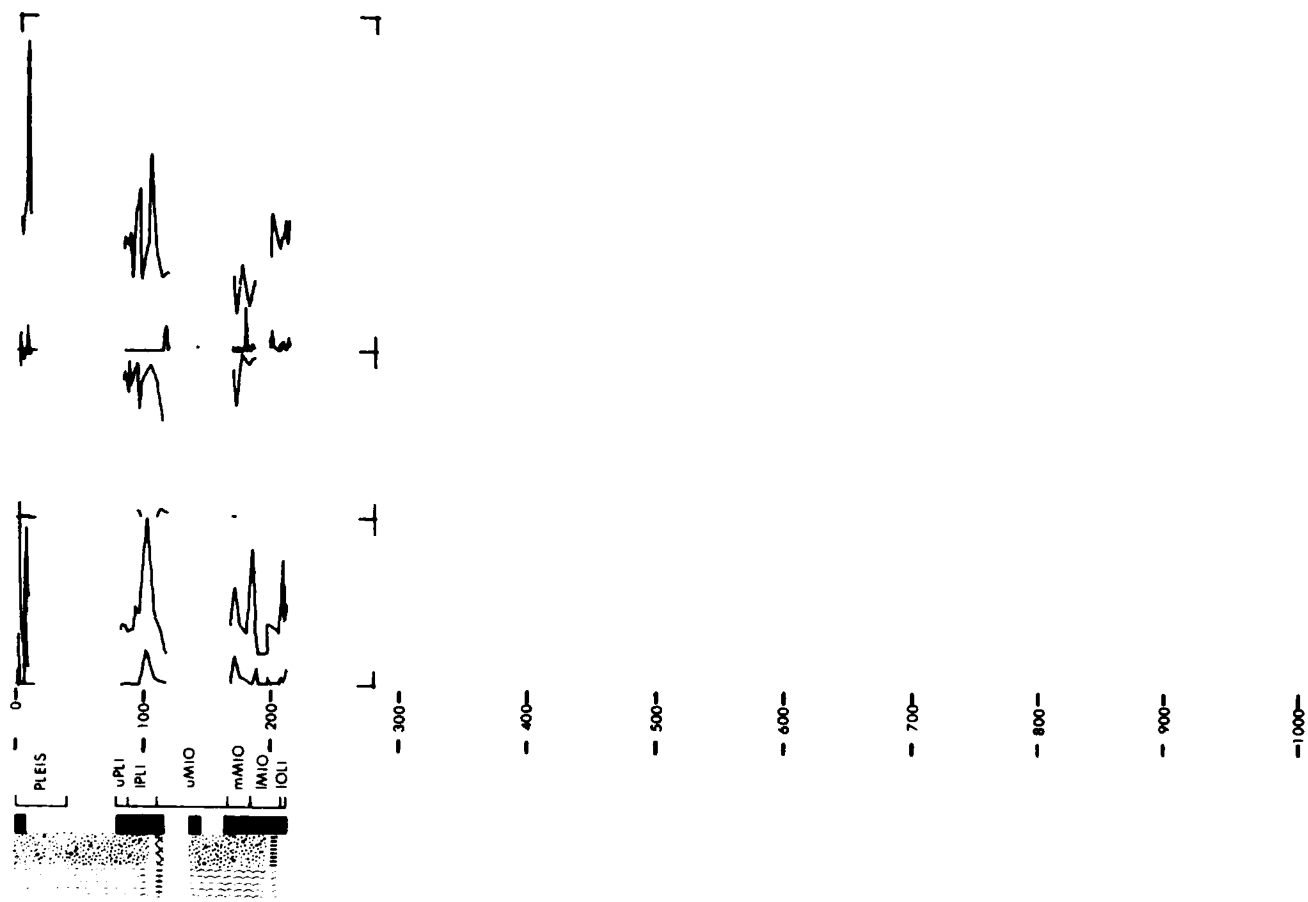
Penetration:
Drilled-- 103 meters
Cored---- 112 meters
Total---- 215 meters
Recovery:
Basement- 2 cores
.45 meters
Total---- 14 cores
86 meters

Site 32 is located on Magnetic Anomaly 13, which is indicated as having as age of 38 million years. The basalt at this site, in spite of the presence of manganese rinds, may have been intruded into the sediments. During latest Early Oligocene time, sedimentation commenced with the deposition of this nannofossil "red" clay. This was followed by zeolite-rich "red" clays and several ash beds. In the early Miocene, either organic productivity increased to permit the appearance of siliceous plankton, or else the sedimentary environment permitted their preservation as fossils. By Middle Miocene, siliceous-fossil beds began accumulating. Volcanic ash was still a common constituent. Sometime in the Late Miocene, the fine terrigenous detritus of the siliceous-fossil mud began to have coarser detritus associated with it, probably resulting from activity of the Delgada Fan. By Early Pliocene time, intermittent influxes of silt had been augmented by the deposition of thick sands, both apparently of turbidite origin. Significant sand deposition may have continued sporadically into the Late Pliocene. By Pleistocene time, only thin silty sands were being deposited among the silty clays and clayey silts.

Detrital sediments; rarely mica or serpentine rich. One thin layer of siliceous sediment; radiolaria rich, occurs in upper Miocene time.



SITE 32 LEG 5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SITE DATA

Position:
- Latitude 39°28.5' N
- Longitude 127°29.8' W

Date: 4/19/69
Time:
Water depth: 4284 meters
Location: Abyssal hill; west of Delgada Fan

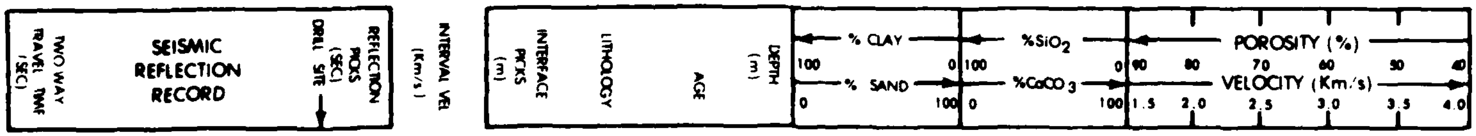
CORE DATA

Penetration:
- Drilled-- 174 meters
- Cored---- 121 meters
- Total---- 295 meters

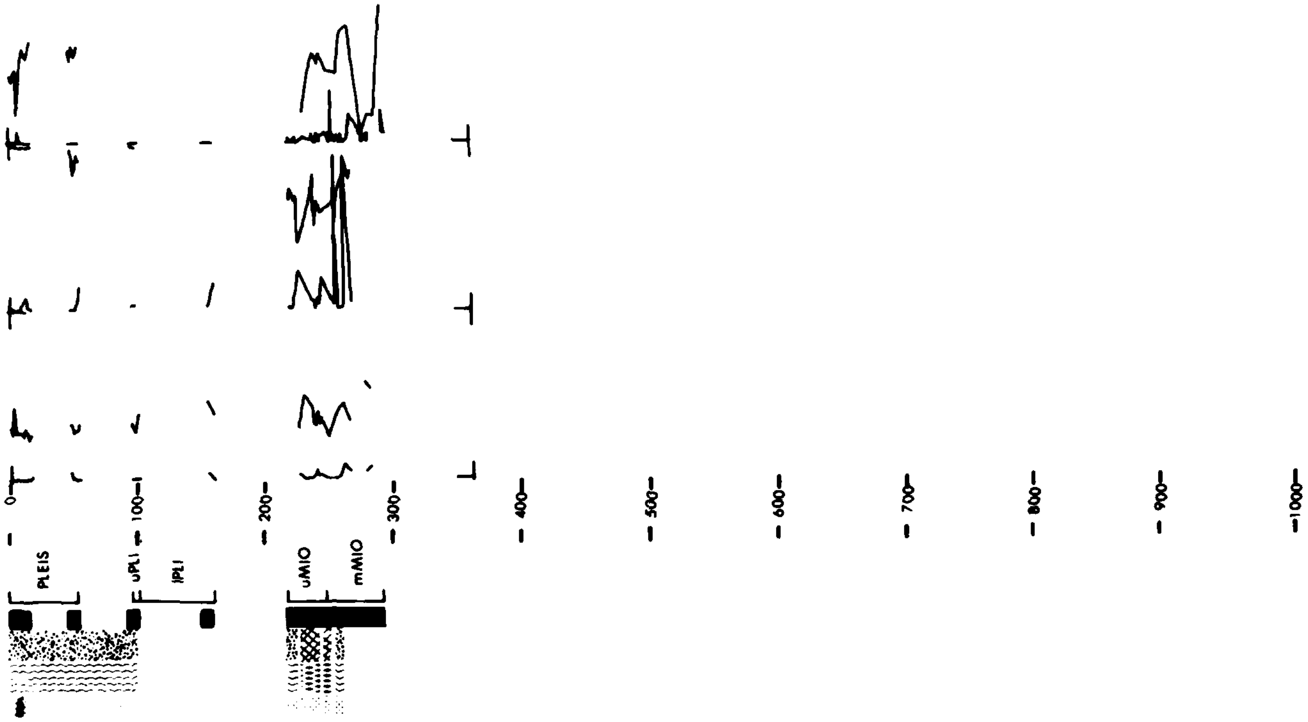
Recovery:
- Basement- 0 cores
- 0 meters
- Total---- 15 cores
- 112 meters

Various admixtures of green terrigenous mud were deposited throughout the section at Site 33. The lower part of the Middle Miocene interval is marked by high calcareous nannoplankton production at the top and bottom. In between are moderate amounts of siliceous fossils. The greatest amount of siliceous fossil deposition, however, began in the upper part of the Middle Miocene and persisted at least into the Late Miocene (possibly even into Early Pliocene as there is a 58 meter uncored interval here). Following this period of biogenous deposition, the number of fossils declined abruptly as the terrigenous muds began to dominate. This condition persisted to the present.

Miocene; interbedded detrital and siliceous radiolaria rich sediment, with two thin layers of calcareous, nannofossil rich, sediment.



SITE 33 LEG 5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SITE DATA

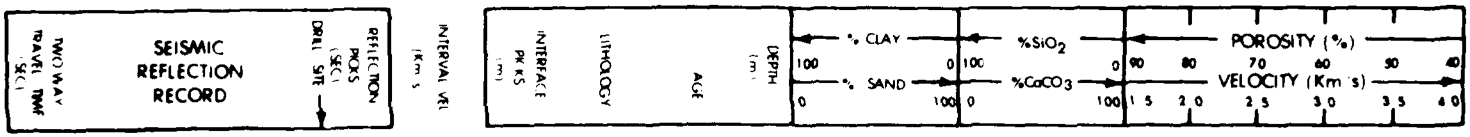
Position:
Latitude 39°28.2'N
Longitude 127°16.5'W
Date: 4/23/69
Time:
Water depth: 4322 meters
Location: Abyssal Plain; west of Delgada Fan

CORE DATA

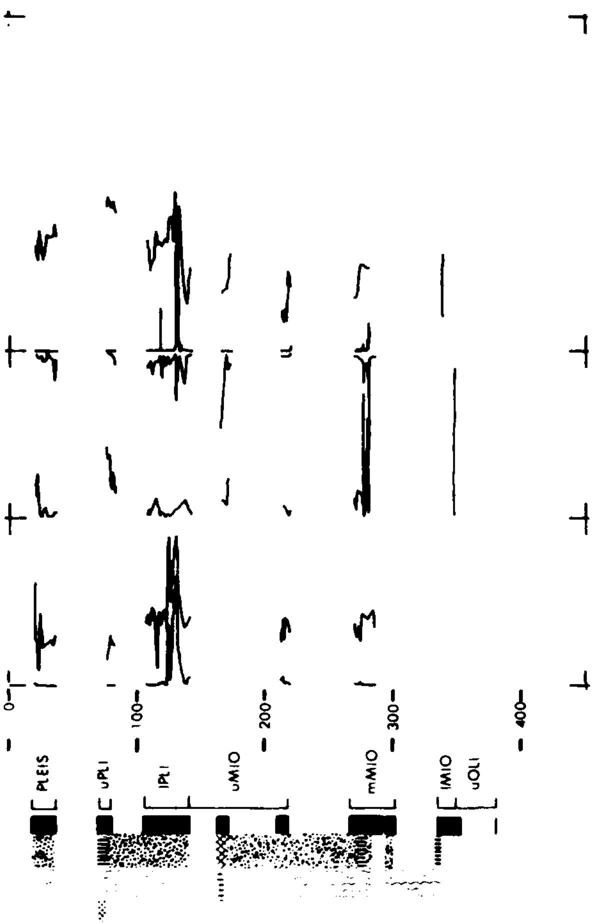
Penetration:
Drilled-- 248 meters
Cored---- 136 meters
Total---- 384 meters
Recovery:
Basement- 1 cores
.5 meters
Total---- 18 cores
106 meters

The negative mangetic anomaly drilled at this site was adjacent to the positive magnetic anomaly at Site 33. Either the calcareous oozes deposited in unit 5 during the Early Miocene/Late Oligocene were subsequently removed by solution or else productivity was very low at this time. In the lower part of the Middle Miocene the fine-terrigenous material continued to be deposited together with more abundant siliceous and calcareous fossil remains and some ash. Later, the sediments were partly altered to silicified and calcareous mudstones. Deposition of siliceous fossils became dominant in the upper part of the Middle Miocene and continued into the Early Pliocene. During the latter period the deposition of turbidite sands took place. Except for a brief interval of nanno-fossil production in Late Pliocene time, the remainder of Cenozoic time was characterized by terrigenous mud deposition. Volcanic activity periodically produced ash beds during parts of the Pliocene and Pleistocene.

Detrital sediments interbedded with calcareous, nannofossil rich, thin layers of sediment. One thin layer of siliceous sediment in upper Miocene time.



SITE 34 LEG 5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SITE DATA

Position:
- Latitude 40°40.4' N
- Longitude 127°28.5' W

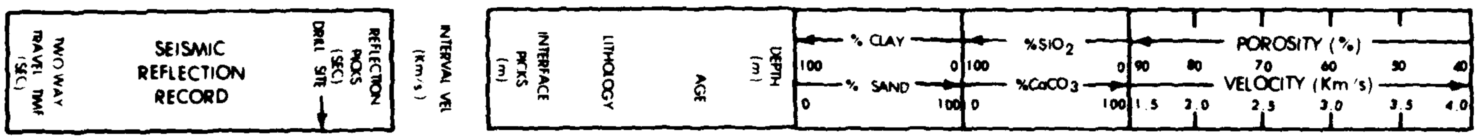
Date: 4/29/69
Time:
Water depth: 3273 meters
Location: Escanaba Trough

CORE DATA

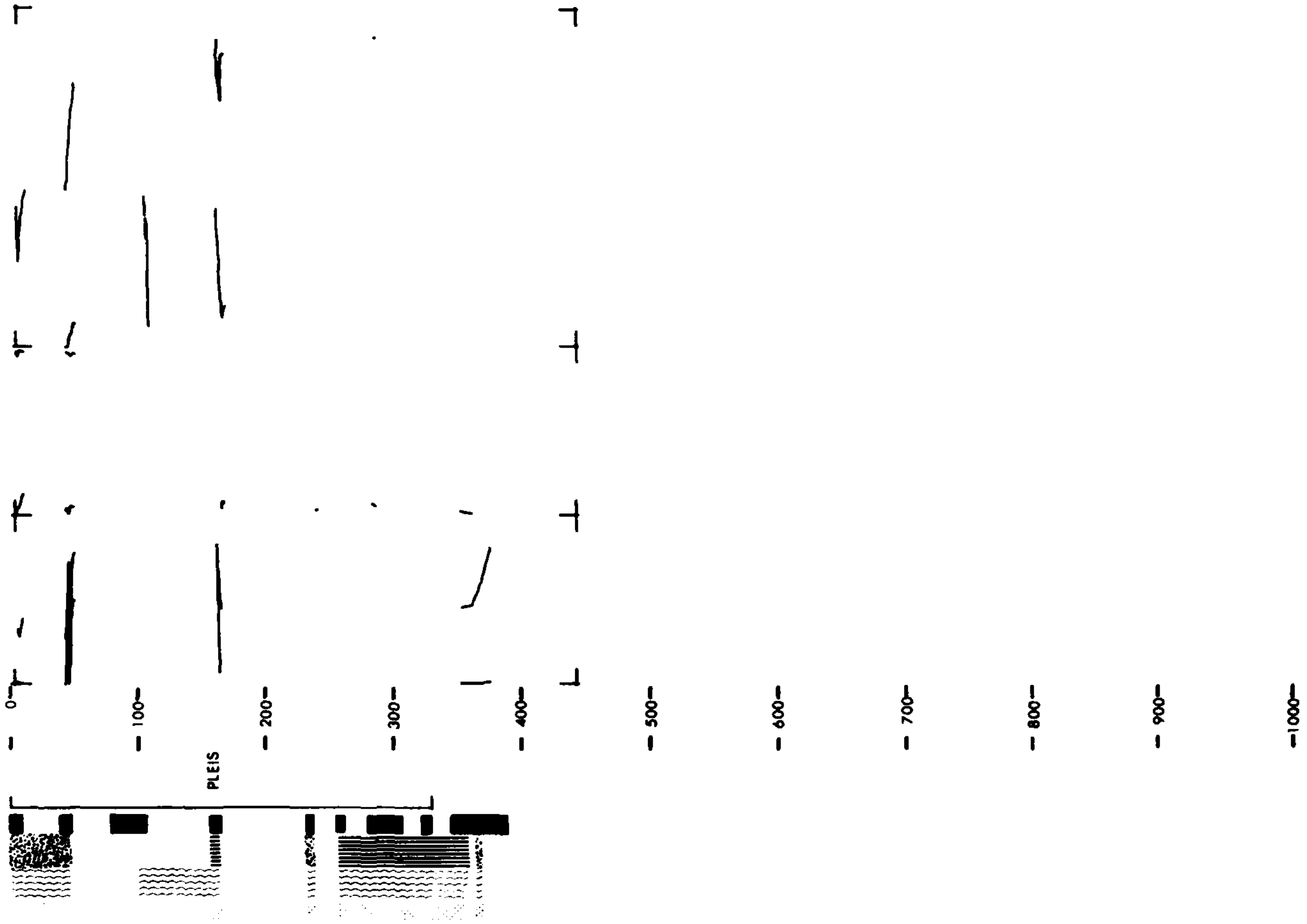
Penetration:
- Drilled-- 250 meters
- Cored---- 140 meters
- Total---- 390 meters

Recovery:
- Basement- 0 cores, 0 meters
- Total---- 17 cores, 95 meters

The section at Site 35 appears to be a Pleistocene terrigenous sequence of alternating fine and mineralogically immature coarser detritus. Without time correlations, the succession of coarser turbidites (units 1 and 2) and the fine detritus in the other units cannot be equated with events outside the Trough. The only paleoclimatological evidence is the presence of cold-water foraminiferal faunas. Considerable post-depositional alteration may be recorded in the fine material, as suggested by the gas content, high bulk density, attenuation of acoustic energy in the laboratory analyses, and the apparent absence of all types of fossils in the lower part of the section. The significance of carbonate particles which were observed in the mud is uncertain. Other distinctive aspects of the material, such as high gamma-ray emission and rhythmic laminations, may be of primary origin. The sedimentation rate has been very high. Sedimentation at present, however, is not sufficiently rapid to bury the low fault scarps on the sea floor. The sequence in the Trough is block faulted with the blocks away from the Trough axis being the upthrown.



SITE 35 LEG 5



SITE DATA

Position:
- Latitude 40°59.1' N
- Longitude 130°06.6' W

Date: 5/06/69
Time:
Water depth: 3273 meters
Location: Abyssal hills region west of Gorda Ridge

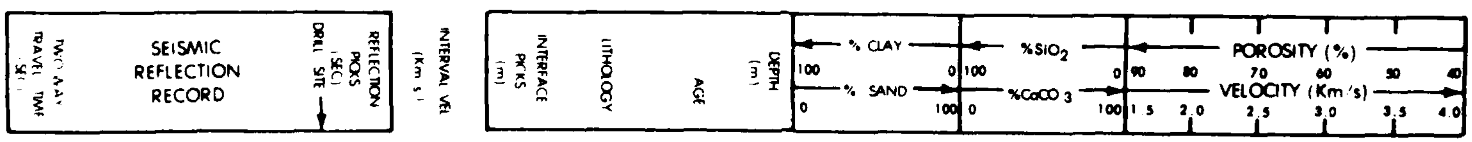
CORE DATA

Penetration:
- Drilled-- 3 meters
- Cored---- 113 meters
- Total---- 116 meters

Recovery:
- Basement- 1 cores, .3 meters
- Total---- 14 cores, 112 meters

Site 36 is located over the negative anomaly (8 million years) to the older site of Anomaly 4. Sedimentation began in the Middle Miocene with the deposition of material which now forms the "red" clay. The siliceous fossils soon ceased to accumulate or be preserved, but conditions were such that the calcareous nannoplankton increased in abundance until accumulation of their remains became the dominant form of sedimentation, as the clay accumulation ceased. In the late part of the Middle Miocene the calcareous ooze deposition apparently ceased. Then sedimentation recommenced in the Late Miocene, the change from pelagic "red" clays to terrigenous sediment in the nannofossil ooze and the presence of reworked Middle Miocene, Oligocene and Eocene nannoplankton in younger units suggest a change in sedimentary environment from that present prior to the hiatus. The hiatus may be caused by bottom current erosion related to the formation of new sea floor topography. During the Pliocene, mud and calcareous ooze deposition continued, with the mud decreasing near the end of the epoch. Most of the sediments of Pleistocene age are foraminiferal-nannofossil oozes. Volcanism played a small role in sedimentation.

Interbedded detrital and calcareous, nannofossil rich, sediments.



SITE 36 LEG 5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SITE DATA

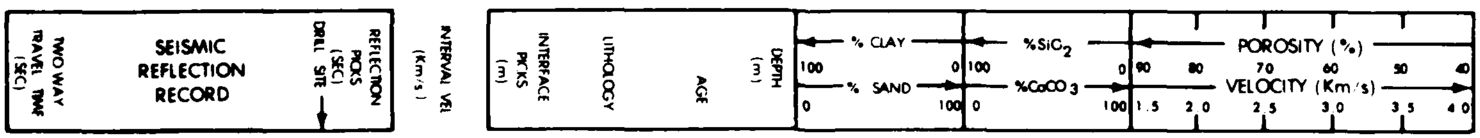
Position:
Latitude 40°58.7'N
Longitude 140°43.1'W
Date: 5/10/69
Time:
Water depth: 4682 meters
Location: Abyssal Hill;
Magnetic Anomaly 10

CORE DATA

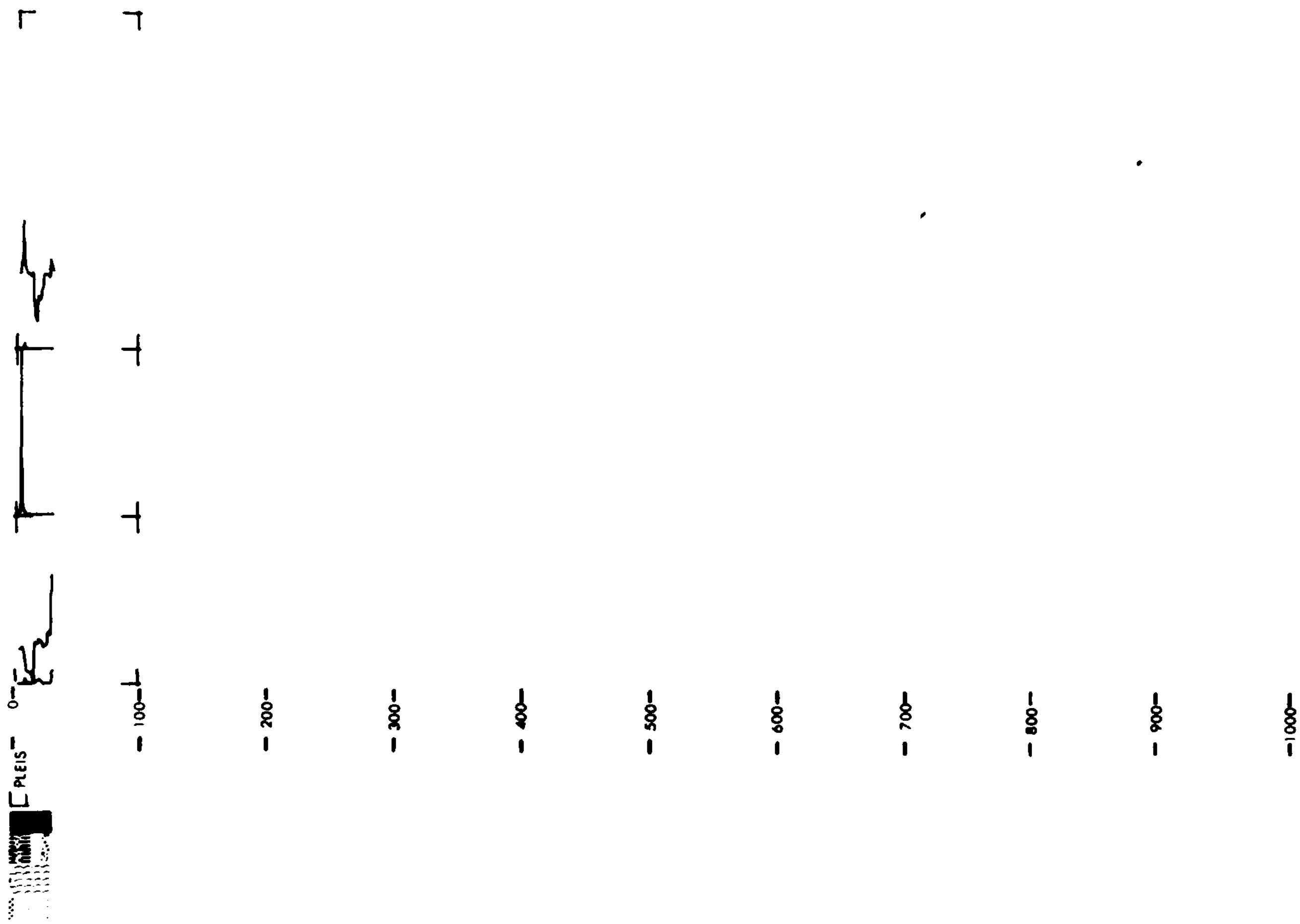
Penetration:
Drilled-- 0 meters
Cored---- 31 meters
Total---- 31 meters
Recovery:
Basement- 2 cores
.03 meters
Total---- 5 cores
30 meters

Although there is no trace of volcanic pumice fragments of fresh ash beds, there are beds of almost pure zeolites which may represent replaced ash beds. There are also nodules of pure zeolites, which may represent zeolitized pumice fragments. Due to the lack of fossils in most of the section, little can be inferred at this time about the geologic history at this site. The magnetic anomaly here is Number 10, which presumably represents an age of 32 million years for the basement. If the basal sediment would have been deposited at an average rate of about 0.1 cm/1000 years. Occasionally in the Pleistocene, conditions were such that calcareous oozes were transported to the site. From the seismic reflection profiles throughout the survey area, the sediments at the drilling site are not considered anomalously thin, but rather to be representative of this abyssal hill region. Lack of contact metamorphism in the basal sediment probably indicates that the basalt basement is not a sill that truncated the lower part of the section.

Detrital sediments, with one thin bed of calcareous sediments, nannofossil rich.



SITE 37 LEG 5



SITE DATA

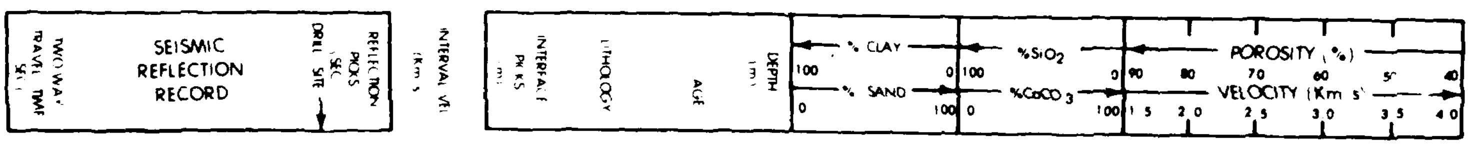
Position:
Latitude 38°42.1'N
Longitude 140°21.3'W
Date: 5/13/69
Time:
Water depth: 5137 meters
Location: Abyssal Hill;
Magnetic Anomaly 22

CORE DATA

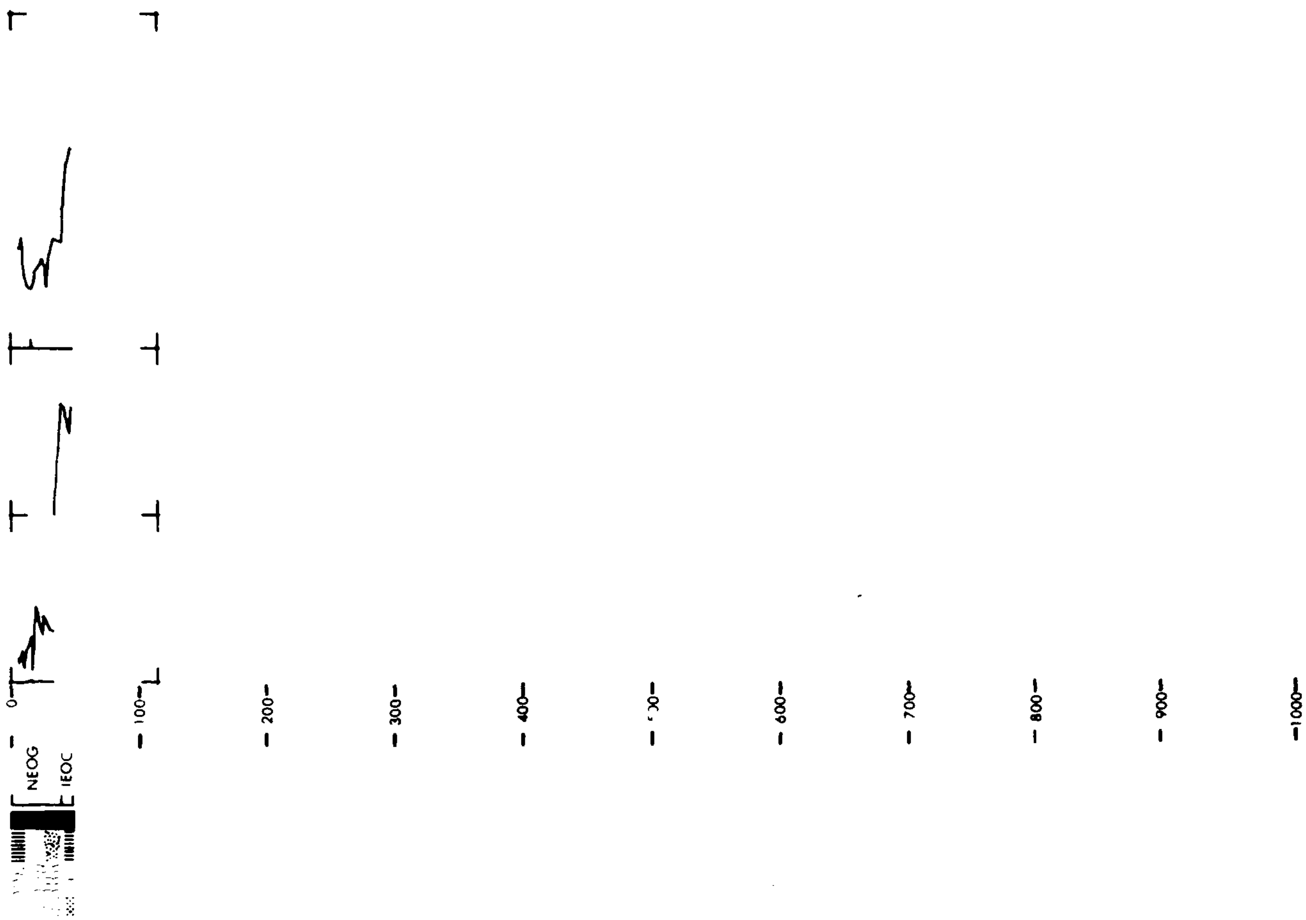
Penetration:
Drilled-- 0 meters
Cored---- 48 meters
Total---- 48 meters
Recovery:
Basement- 1 cores
0 meters
Total---- 6 cores
48 meters

The location of Site 38 with regard to the magnetic anomalies is on Anomaly 22 which is 56 million years old (upper part of the Paleocene). The oldest fossils indicate an age for the basal sediments of only about 50 million years. Carbonate deposition was the dominant sedimentary process in the Early Eocene, although amorphous iron oxides were apparently deposited with the ooze. Some time later, a change in the sedimentary environment occurred. The accumulation of calcareous ooze ceased, and was followed by deposition of the amorphous iron oxides. Presumably this change in the sedimentary environment also initiated the dissolution of fossils in the upper part of the ooze, although this is speculation. During this period the environment appears to have been uniform, other than for ash falls near the site. As the time span represented by the iron oxide-rich sediment is not documented, only a crude estimate of rate of sedimentation can be made. Based on a 50 million year maximum year age for the ooze, and by assuming that continuous deposition has occurred to the present, and average rate for the upper 39 meters of the sediment column clay is 0.8 m/m.y.

Calcareous sediments of lower Eocene age nannofossil rich.



SITE 38 LEG 5



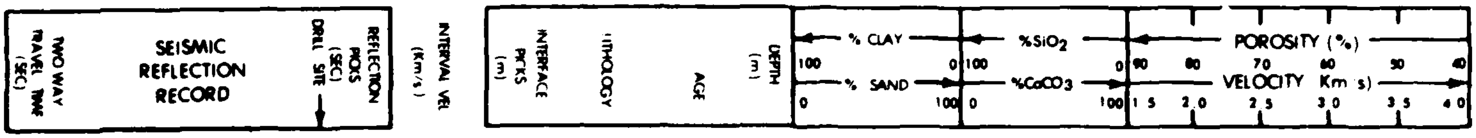
SITE DATA

Position:
  Latitude 32°48.3'N
  Longitude 139°34.3'W
Date: 5/16/69
Time:
Water depth: 4929 meters
Location: Abyssal hill between Pioneer and Murray Fracture Zones

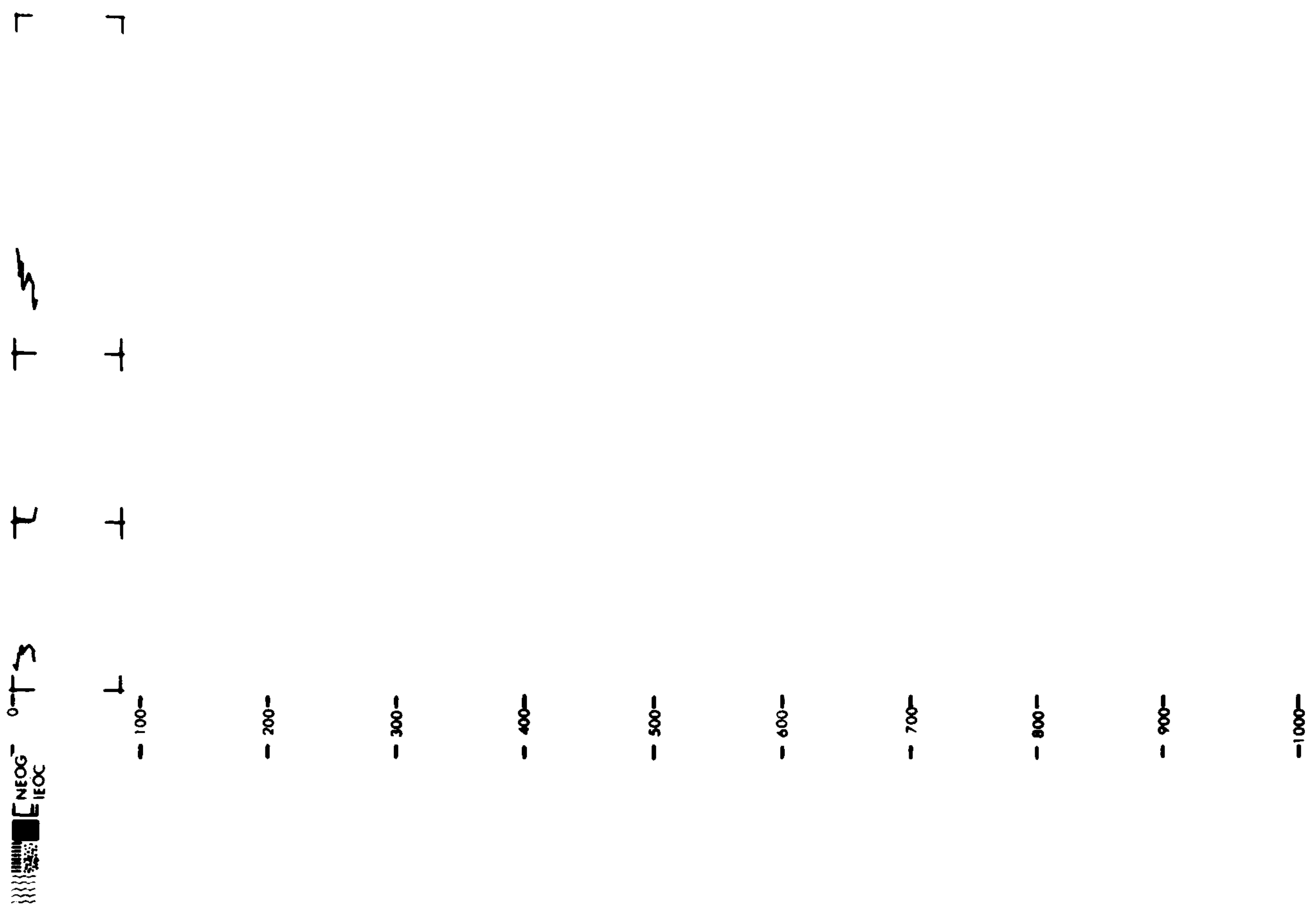
CORE DATA

Penetration:
  Drilled-- 0 meters
  Cored---- 17 meters
  Total---- 17 meters
Recovery:
  Basement- 1 cores
  .03 meters
  Total---- 2 cores
  17 meters

Here, as at Site 38, the age determined by studies of microfossils is younger than the age expected from the magnetic anomaly. The basement rock is a block aphanitic basalt. In the amorphous iron oxide sediment overlying the basement, only small changes in lithology and color were noted. As in the bottom core at Site 38, the sediment directly overlying the basement at Site 39 contains calcareous microfossils. In general, with increasing distance above basement, zeolite content increases and the amount of amorphous iron oxide pigmentation decreases. The reasons for the microfossil preservation and the changes in both zeolite content and iron pigmentation are not known at present. Deposition of calcareous fossils occurred in Early Eocene time. Later, the accumulation of calcareous material ceased and amorphous iron oxides were deposited.



SITE 39 LEG 5



SITE DATA

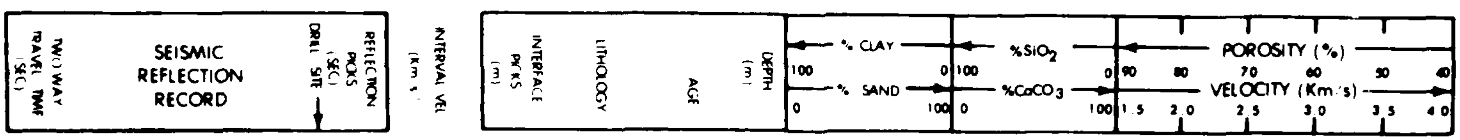
Position:
Latitude 19°47.6'N
Longitude 139°54.1'W
Date: 5/20/69
Time:
Water depth: 5183 meters
Location: Abyssal hill between Molokai and Clarion Fracture Zones

CORE DATA

Penetration:
Drilled-- 2 meters
Cored---- 154 meters
Total---- 156 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 19 cores
129 meters

The sediment column is composed of three distinct units which reflect different conditions of deposition. The bottom unit is a calcareous (?) ooze with some thin ash beds of siliceous mudstone and chert. At 143 meters, there is a change to relatively uniform radiolarian ooze. At 13 meters, the clay content increases, and at 10 meters, the lithology changes gradually to zeolitic "red" clay. Phillipsite nodules and streaks probably represent altered ash layers. Scattered fragments of pumice also reflect the influence of volcanic contributions. Dolomite rhombs in the lower cores emphasize the importance of diagentic changes during lithification of deep-sea sediments. This site was chosen to be representative of possible high tropical productivity during Eocene time; and, to date it has provided the best record of Eocene radiolarian evolution in the Pacific Ocean Basin. The reasons for the changes from calcareous (?) ooze to radiolarian ooze and from radiolarian ooze to zeolite "red" clay are not clear. It is apparent, however, that very little sediment has accumulated since Late Eocene time.

Siliceous sediments, radiolaria rich, with one layer diatom rich. One thin layer of detrital, serpentine rich, occurs in middle Eocene time.



SITE 40 LEG 5

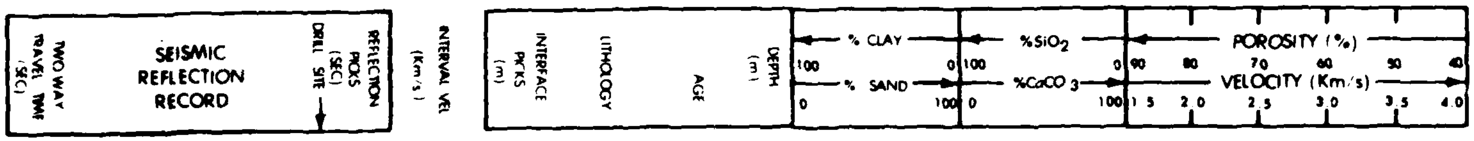
SITE DATA

Position:
Latitude 19°51.2'N
Longitude 140°02.9'W
Date: 5/23/69
Time:
Water depth: 5339 meters
Location: Abyssal hill; Magnetic Anomaly 27

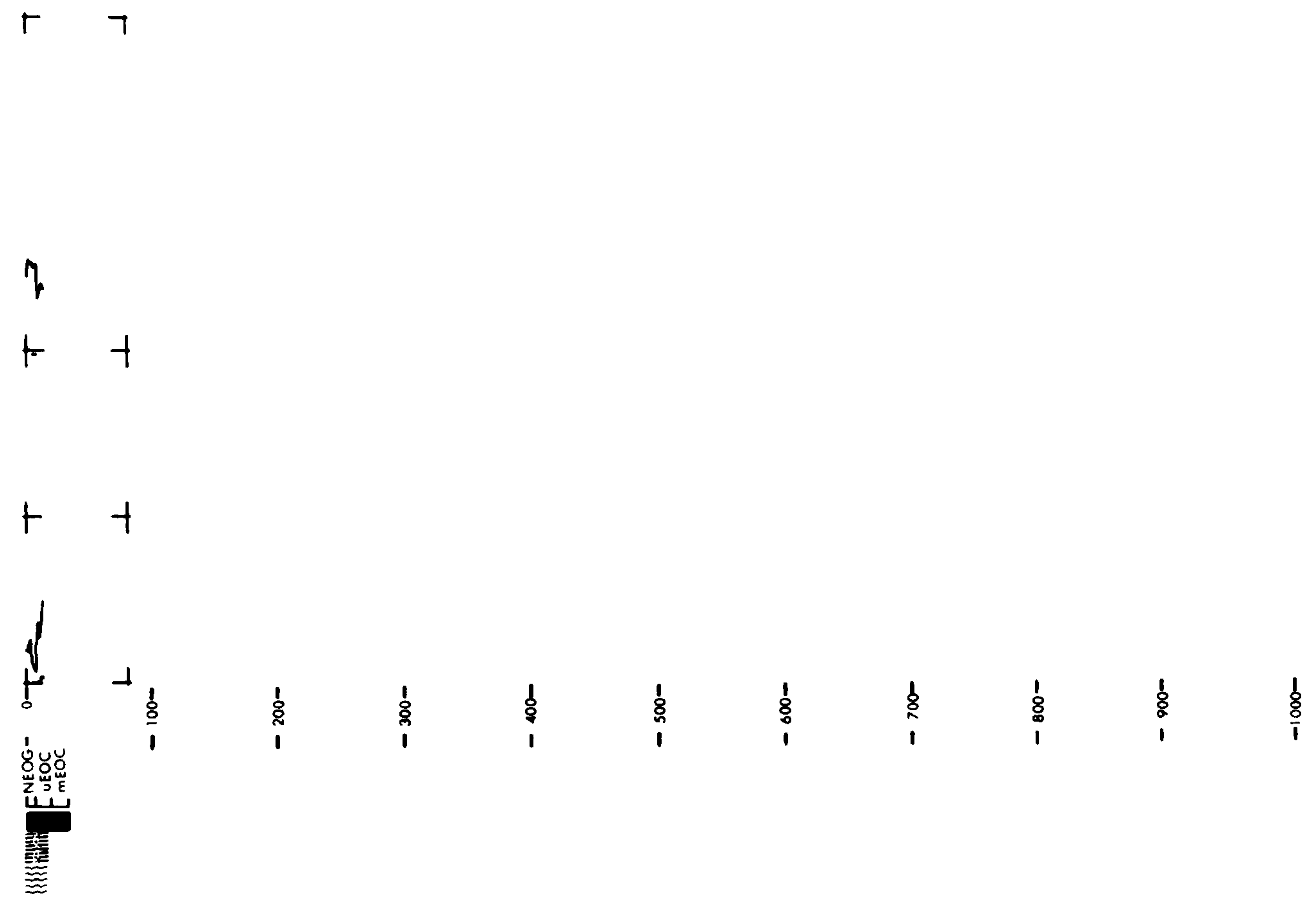
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 34 meters
Total---- 34 meters
Recovery:
Basement- 1 cores
.03 meters
Total---- 5 cores
26 meters

At Site 41, thirty-four meters of sediment cover the basement rocks. Fossils are Middle and Late Eocene in age in Cores 2, 3, and 4. Basement rock is black glassy basalt. The sediment column is divided into two units: a radiolarian ooze and a "red" clay. Radiolarian ooze occurs between 18 meters and basement, and is very similar to the radiolarian ooze recovered at Site 40. Some thin beds of "red" clay may alternate with the radiolarian ooze. Except for a 4-meter section, the overlying "red" clay unit is zeolitic. Colors of the "red" clays are gray-brown and yellow-brown. Upper Tertiary fossils occur in the upper part of this unit, and Upper Eocene fossils occur in the lower part. This site probably provided a sediment section that is more typical of this part of the Pacific than the section recovered at Site 40. The sites are only 15 km apart, yet three significant differences are apparent. Neither calcareous ooze nor chert occurs at Site 41. Also, the ages of the oldest sediments differ. Again, as at Site 40, the change from radiolarian ooze to "red" clay (Upper Eocene) indicates changing oceanic conditions.



SITE 41 LEG 5



SITE DATA

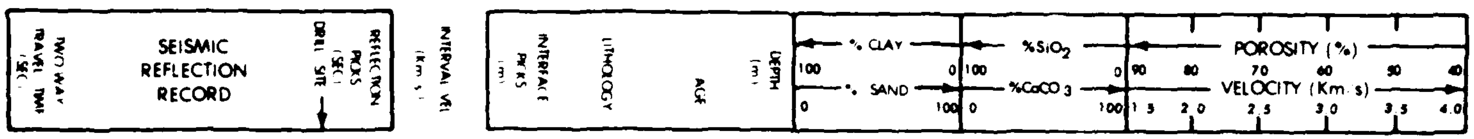
Position:
Latitude 13°50.6'N
Longitude 140°11.3'W
Date: 5/26/69
Time:
Water depth: 4848 meters
Location: Abyssal hill; between Clarion and Clipperton Fracture zones

CORE DATA

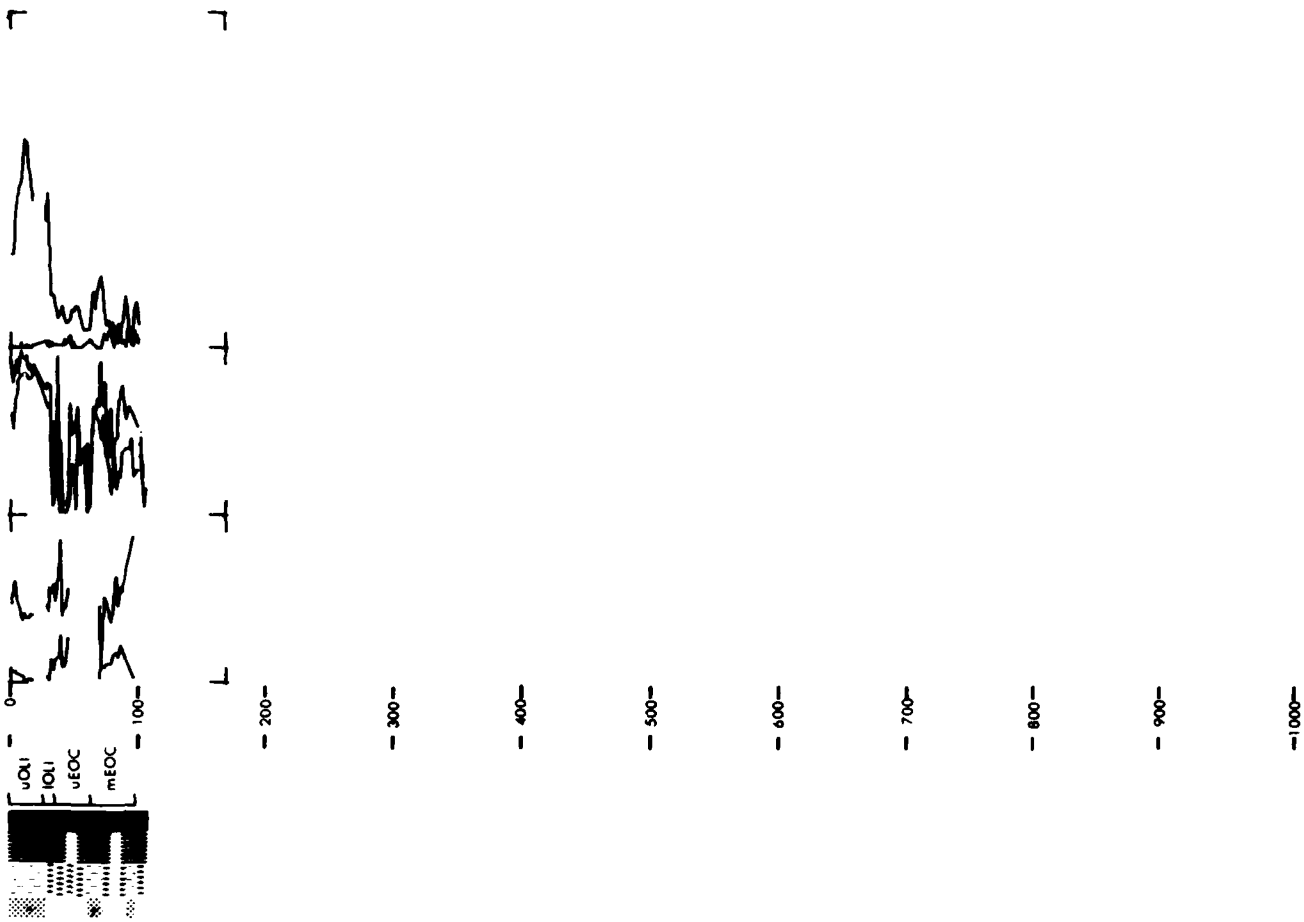
Penetration:	42	42A	
Drilled--	0	105	meters
Cored----	100	8	meters
Total----	100	113	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	11	3	cores
	92	7	meters

The reason for the absence of younger Cenozoic sediments at this hole is not known. However, the Argo site survey indicated the presence of bottom currents here. The depositional record extends from Middle Eocene to Late Oligocene time. During this period only biogenous sediments were deposited, except for minor quantities of red clay. Traces of volcanic ash occur in units 1 and 2, whereas, pumice fragments are found throughout the section. Some of the volcanic ash has become zeolitized. Although manganese nodules occur in units 2, 3 and 4, their subsurface occurrences may be due to down-hole contamination.

Interbedded calcareous, nannofossil rich, and siliceous, radiolaria rich, sediments.



SITE 42 LEG 5



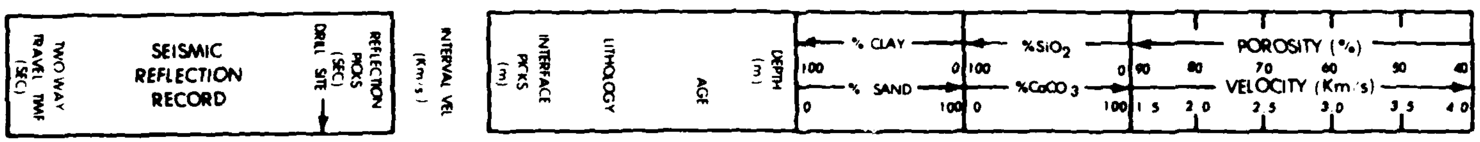
SITE DATA

Position:
  Latitude 17°06.6' N
  Longitude 151°22.5' W
Date: 6/01/69
Time:
Water depth: 5405 meters
Location: Outer slope of the Hawaiian Arch

CORE DATA

Penetration:
  Drilled-- 1 meters
  Cored---- 8 meters
  Total---- 9 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 2 cores
  8 meters

The composition of the sediment suggests derivation from a volcanic source. The sand in this sediment is not definable. Although turbidity currents from the Hawaiian Ridge might be a possible transporting mechanism, the site lies seaward of the arch around the Ridge. The arch would appear to be a barrier to the delivery of sediment to Site 43 by turbidity currents.



SITE 43 LEG 5

0 100 200 300 400 500 600 700 800 900 1000

SITE DATA

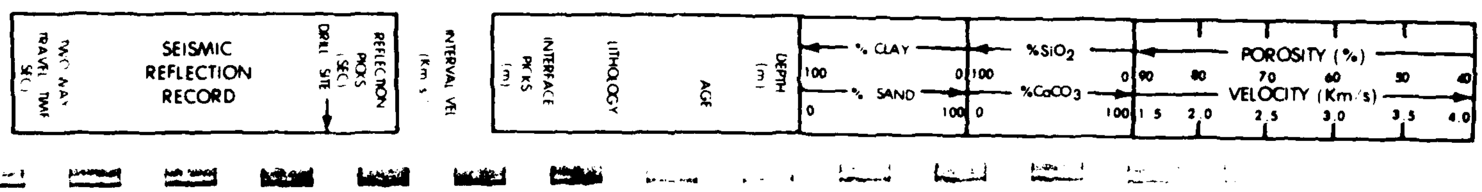
Position:
Latitude 19°18.5' N
Longitude 169°00.9' W
Date: 6/14/69
Time: Z
Water depth: 1478 meters
Location: Horizon Ridge Guyot

CORE DATA

Penetration:
Drilled-- 40 meters
Cored---- 36 meters
Total---- 76 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 5 cores
28 meters

The sediments on this mountain are, as expected, mainly foraminiferal-nannoplankton oozes. While the Neogene was penetrated without recovery of samples, a good sequence of cores was obtained through the Lower Oligocene, the Upper Eocene, and most of the Middle Eocene. The sediment is so soft and watery that it was badly disturbed inside the core barrel. Traces of brown chert were encountered in the Oligocene and Upper Eocene, and more massive vitreous brown layers in the Middle Eocene; the latter may be confidently identified with the prominent acoustic reflecting horizon shown on the profiles, and terminated the drilling here. No new light was shed on the sediments below this reflector, nor on the composition of the underlying, "opaque" material. It seems likely that Eocene sediments here rest on basalt.

Sediments nannofossil rich.



SITE 44 LEG 6

0 100 200 300 400 500 600 700 800 900 1000

SITE DATA

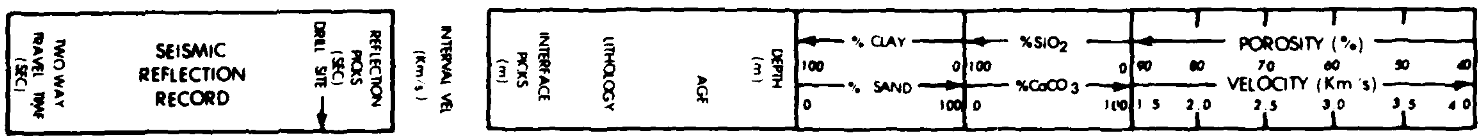
Position:
Latitude 24°15.9'N
Longitude 178°30.5'W
Date: 6/17/69
Time:
Water depth: 5508 meters
Location: Abyssal Floor of the Pacific

CORE DATA

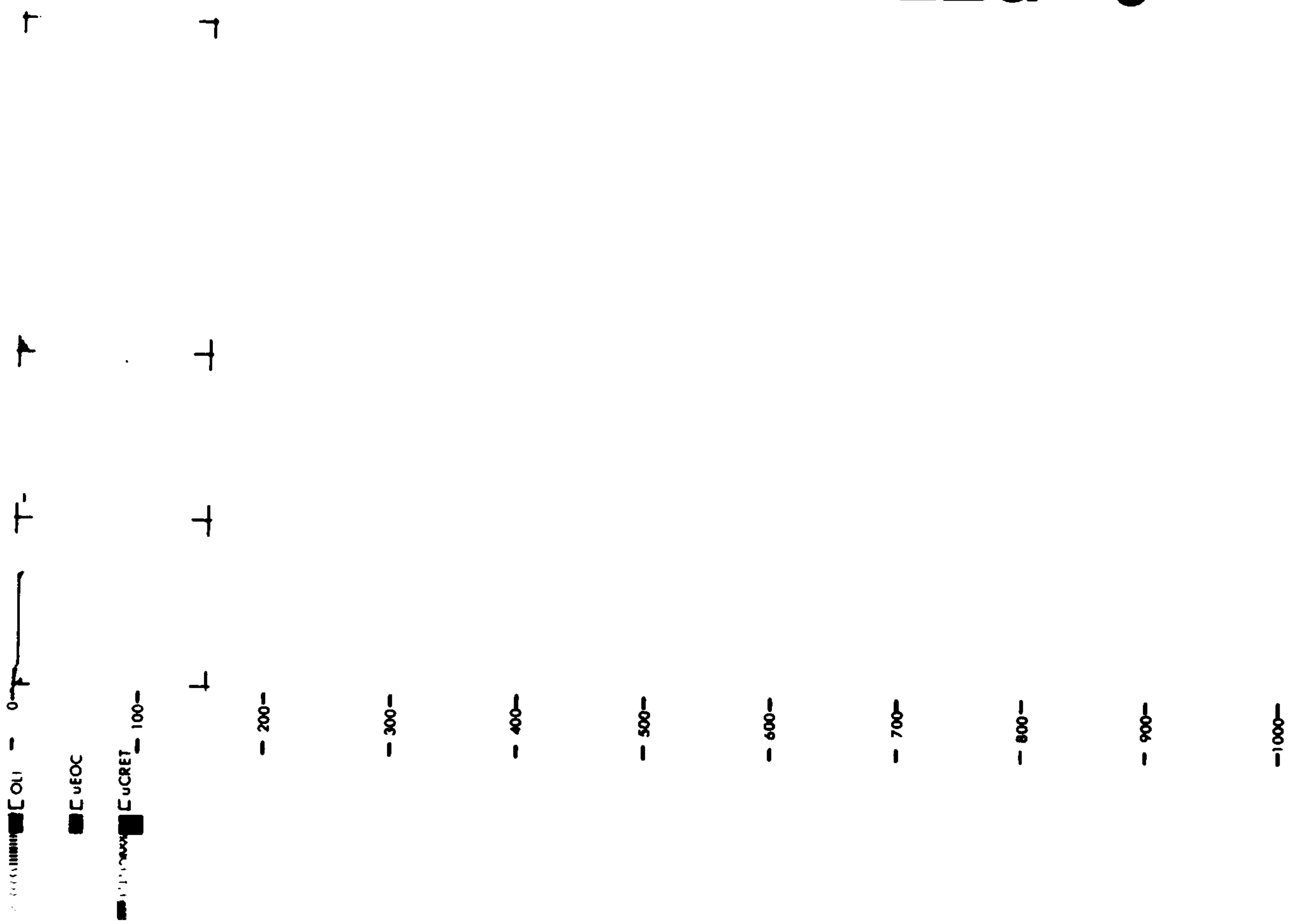
Penetration:	45	45A	
Drilled--	18	69	meters
Cored----	0	36	meters
Total----	18	105	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	0	4	cores
	0	3	meters

The upper opaque layer at Site 45 is a brown zeolitic deep-sea clay containing layers of volcanic tuff and ash; some of these are soft and others are lithified and partly silicified. The deepest core, taken from the general contact zone of the upper opaque and lower transparent acoustic yielded small pieces of hard Cretaceous (Cenomanian) tuffaceous limestone, and chert, and free Cenomanian planktonic foraminifera. The general lithic sequence is one from chalk and limestone in the Cenomanian to brown clay with ash in the Eocene and Oligocene. The presence of Campanian to Maestrichtian and Eocene coccoliths and foraminifera in the last core, presumably as cavings from up-hole, suggests that the carbonate compensation depth was crossed sometime before or during the Eocene. The presence of silt-grade volcanic tuff—not encountered in any of the other sites drilled by Leg 6 in the Pacific—is evidence of near-by volcanism in late Cretaceous to Oligocene time. The most likely source would appear to be the Hawaiian Ridge, to the north—in particular the region near Midway.

One thin layer of calcareous sediment occurs in upper Cretaceous time.

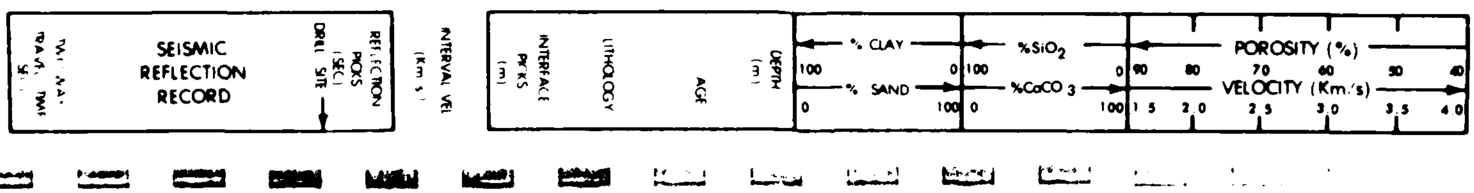


SITE 45 LEG 6

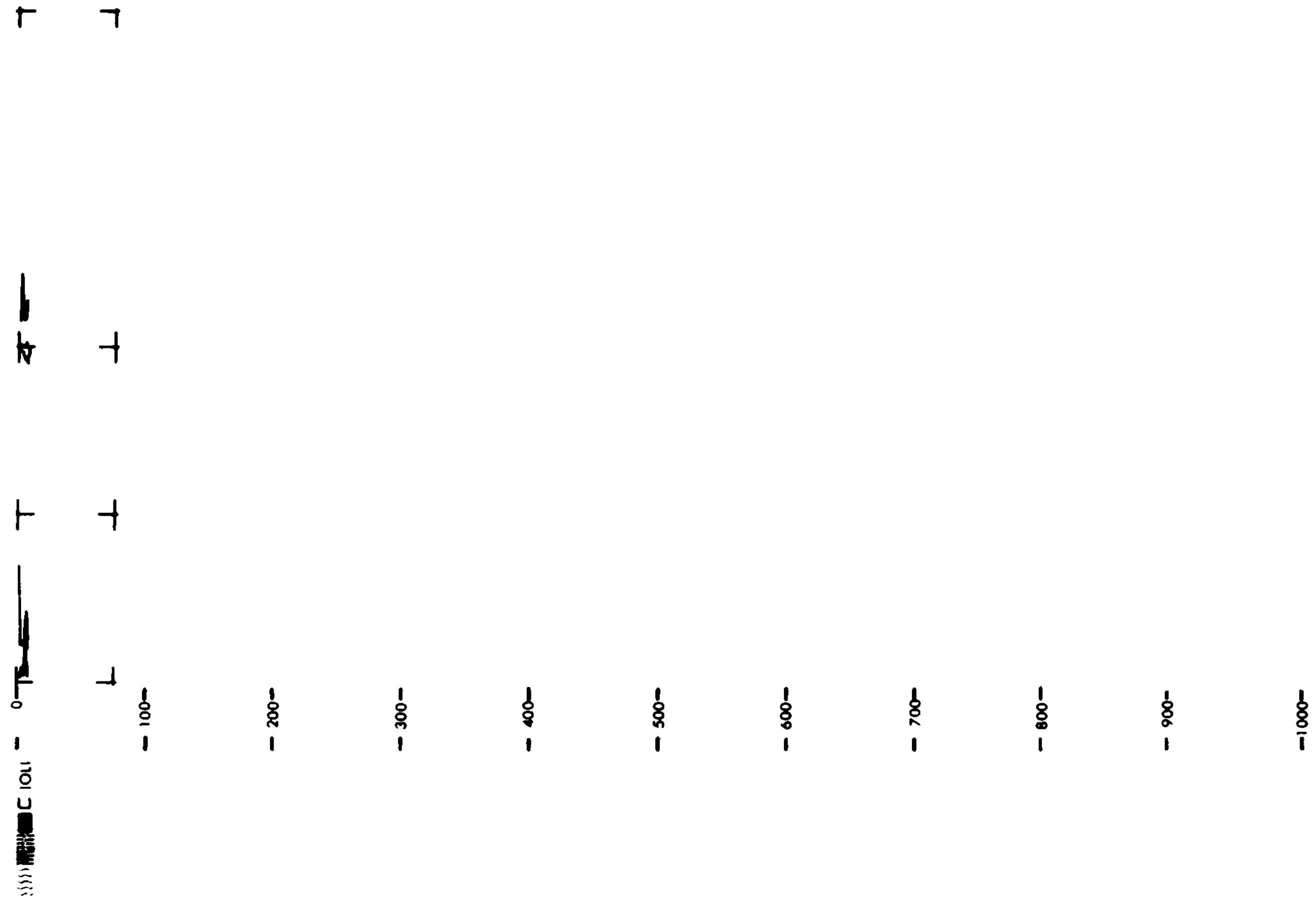


SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	27°53.0' N	Drilled--	0 meters
Longitude	171°26.3' E	Cored----	9 meters
Date:	6/25/69	Total----	9 meters
Time:		Recovery:	
Water depth:	5769 meters	Basement-	0 cores
Location:	Fracture Zone Ridge on Abyssal Floor		0 meters
		Total----	1 cores
			9 meters

The feature drilled is a tilted fault block with Cretaceous exposed on the southeast flank. The first and only core yielded a mixture of watery Eocene brown clay and of Cretaceous ash, radiolarian chert, and possibly brown clay as well. The Cretaceous assignment is based on Radiolaria which, while of Cretaceous type, are too poorly preserved to be specifically or even generically identifiable; no closer age assignment has been achieved. The rock types in this core are much like those recovered from the "upper opaque" at Site 45, with the addition of radiolarian chert. It may, therefore, be concluded that the upper opaque layer contains beds as old as Cretaceous. Drilling probably continued into the lower part of the Upper Opaque layer; this may imply either that the lower transparent layer is thinned in this structure (which may predate most of the sediments), or that the vague reflection on the profile record lies above Horizon B'.



SITE 46 LEG 6



SITE DATA

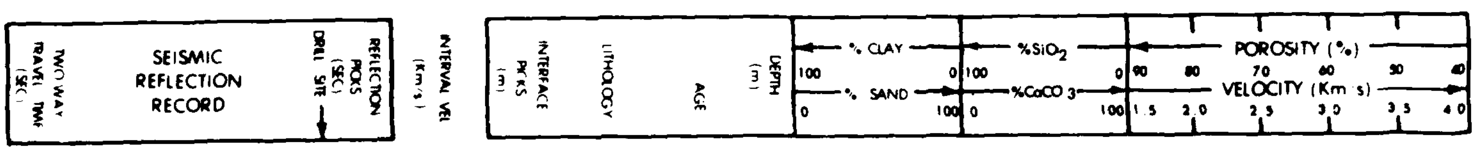
Position:
Latitude 32°26.9'N
Longitude 157°42.7'E
Date: 6/28/69
Time:
Water Depth: 2689 meters
Location: Crest of Shatsky Plateau

CORE DATA

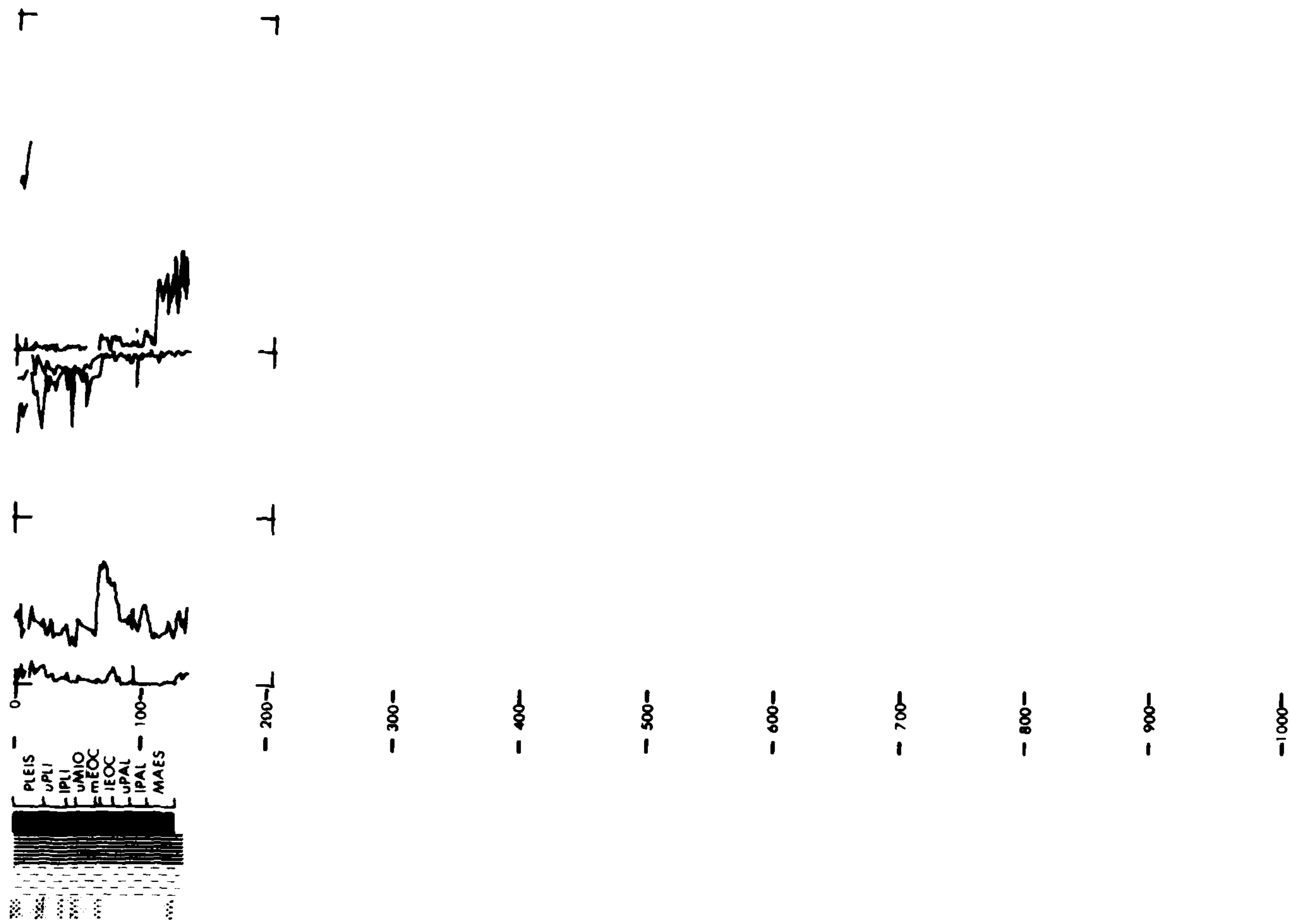
Penetration:	47	47A	47B	
Drilled--	0	102	9	meters
Cored----	9	10	120	meters
Total----	9	112	129	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	1	2	14	cores
	9	2.4	103	meters

The drilling at Site 47 shows that the Shatsky Rise has a thin veneer of late Miocene-Pleistocene carbonate ooze with well-preserved siliceous fossils. The aspect is that of a high-latitude biota with some admixture of tropical species, and this material offers a new insight into the paleobiogeography of the northwestern Pacific, and important material for analysis with the California Neogene. A distinct hiatus, representing most of the Miocene, all the Oligocene, and part of Eocene time separates this veneer at Site 47 from the next-lower unit. The underlying section is an apparently continouosly deposited sequence of Maestrichtian, Paleocene and Eocene carbonate oozes, unfortunately badly disturbed in the process of coring. This section is the first good biostratigraphic and paleontologic interest. The foraminifera and coccoliths are remarkably well-preserved, and contain numerous benthonic as well as planktonic species. Siliceous fossils are absent, while Inoceramus prisms are common. Cretaceous chert occurs in lenticular masses, and was encountered at different depths in each hole.

Calcareous sediment; nannofossil rich.



SITE 47 LEG 6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SITE DATA

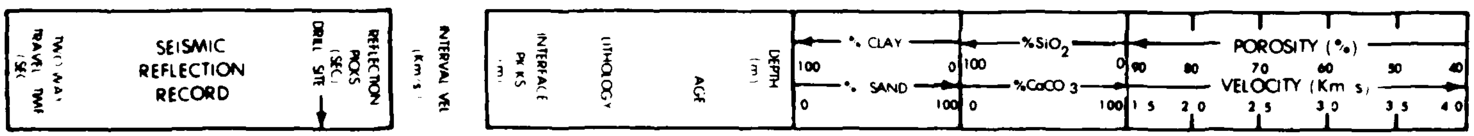
Position:
Latitude 32°24.5'N
Longitude 158°01.3'E
Date: 6/30/69
Time:
Water Depth: 2619 meters
Location: Crest of Shatsky Plateau

CORE DATA

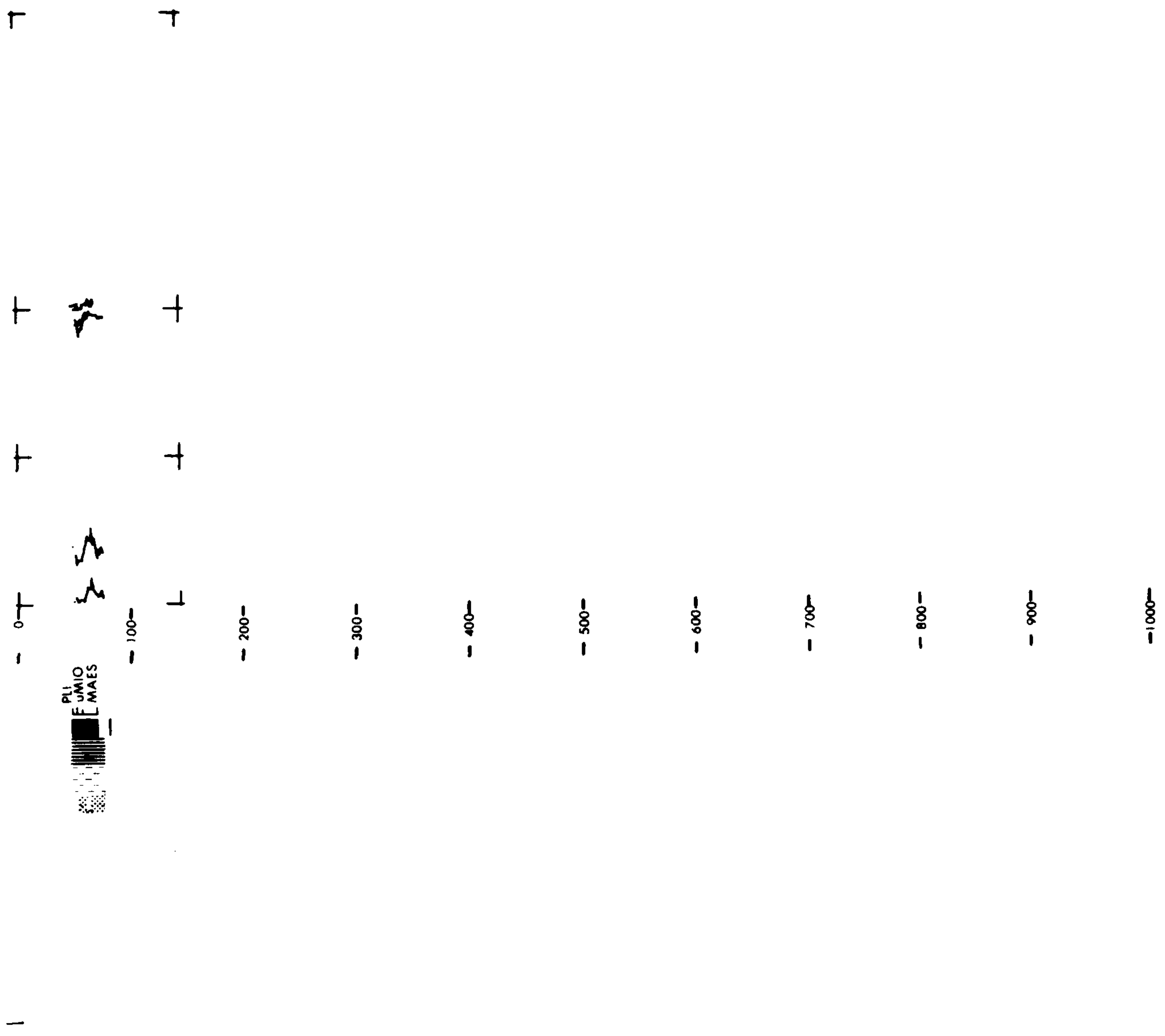
Penetration:	48	48A	48B	
Drilled--	84	48	51	meters
Cored----	0	1	21	meters
Total----	84	49	72	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	1	1	3	cores
	0	.6	21	meters

At Site 48, the Upper Miocene rests directly on Middle Maestrichtian; the unconformity noted at the base of the Upper Miocene at Site 47 thus cuts deeper into the section at Site 48, having truncated the Eocene, Paleocene and Upper Maestrichtian. The variable depth at which cherts were encountered at Site 48 confirms the conclusion reached at Site 47, that the cherts in these chalk oozes do not form beds of continuous thickness, but lense in and out over short lateral distances. Specimens recovered in the cores show a highly angular surface, and a differentiation into a vitreous core and chalky rind. These cherts are thus much like the flints in the chalk of Europe. The excellent faunas and floras of the Middle Maestrichtian, slightly older than those penetrated at Site 47, add significant paleontologic information. Traces of Inoceramus are abundant.

Calcareous sediment, mostly nannofossil rich.



SITE 48 LEG 6



SITE DATA

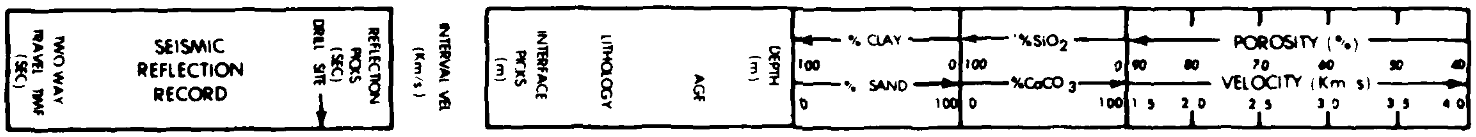
Position:
Latitude $32^{\circ}24.1'$ N
Longitude $156^{\circ}36.0'$ E
Date: 7/02/69
Time:
Water depth: 4282 meters
Location: West flank of Shatsky Rise

CORE DATA

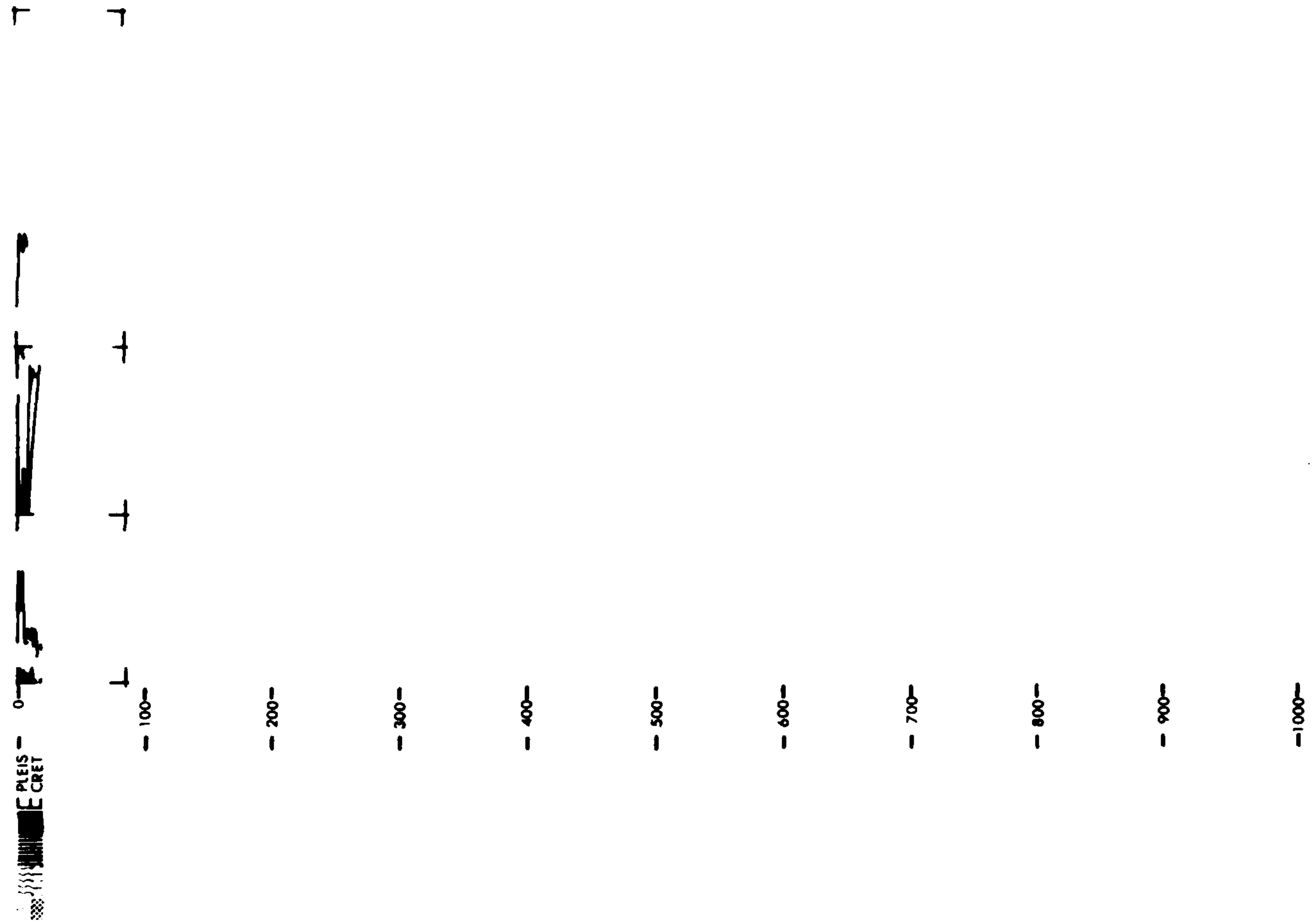
Penetration:	49	49A	
Drilled--	10	3	meters
Cored----	10	15	meters
Total----	20	18	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	2	2	cores
	9.7	10	meters

Site 49 tested the sedimentary sequence about 100 meters above the basement and found cherty chalk ooze, of Late Jurassic or Early Cretaceous age, below Pleistocene brown clays and shard-rich and zeolitic muds with manganese and detrital chert derived from the Cretaceous. The absence of planktonic foraminifera and the nature of the coccoliths show the carbonates to be pre-Aptian. The coccoliths show little variety, and belong to the species which are known to range from the Late Jurassic (Kimmeridgian) through the Neocomian. Species and larger taxa (Nannoconus), which are normally present in and distinctive of the various Neocomian stages, are absent, and this leads to the suspicion that the core beds may be of Jurassic age; however, positive evidence of Jurassic age is lacking. Forced to abandon this site because of cherty rock encountered without sufficient overburden, the drilling vessel moved a short distance down-dip to Site 50.

Pleistocene; detrital with one thin layer of calcareous, nannofossil rich sediment. Earlier calcareous sediment occasionally nannofossil rich.



SITE 49 LEG 6



SITE DATA

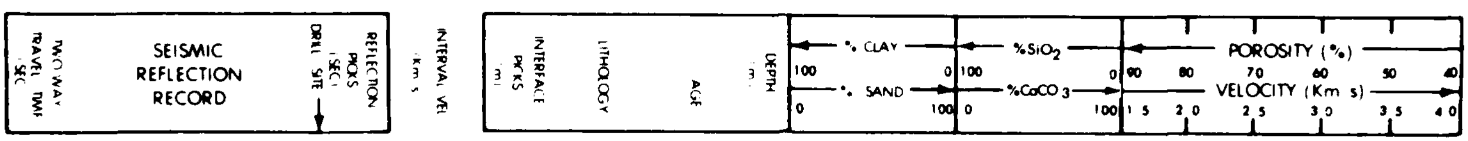
Position:
  Latitude 32° 24.2' N
  Longitude 156° 34.3' E
Date: 7/03/69
Time:
Water depth: 4487 meters
Location: West flank of Shatsky Rise

CORE DATA

Penetration:	50	50A	
Drilled--	38	5	meters
Cored----	7	31	meters
Total----	45	36	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	2	4	cores
	2.7	26	meters

At Site 50 Late Jurassic cherty chalks are overlain by Pleistocene brown clay, with abundant volcanic constituents, some marly beds, and siliceous fossils. The late Jurassic (Kimmeridgian and early Tithonian) age assignment is based on the occurrence of coccoliths transitional between Stephanolithion bigoti and S. laffitei. The bottom of the hole yielded chert pebbles and cobbles of detrital origin, with rounded edges and manganese coating. Such pebbles are also seen in the Pleistocene clays above. Some of them contain Mid-Cretaceous planktonic foraminifera, presumably derived from the Cretaceous subcrops up the slope. These pebbles much have caved into the hole, out of the Pleistocene muds. In addition to these, the bottom cores also yielded pebbles of types not seen above—specifically, a piece of hematitic jasper of the sort associated with ophiolite sequences, and a pebble of amygdaliodal basalt. It seems possible that these pebbles were derived from a basal conglomerate under the Jurassic chalks. In any event, these pebbles indicate the basalt and jasper play a role in the acoustically "opaque" rocks below Horizon B'.

One thin layer of calcareous sediment, nannofossil rich, occurs in Pleistocene time.



SITE 50 LEG 6

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SITE DATA

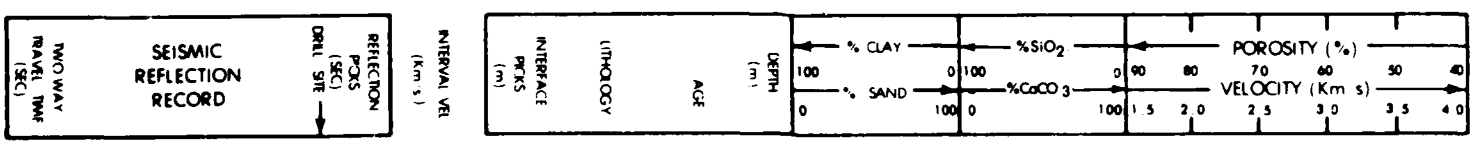
Position:
Latitude 33°28.5' N
Longitude 153°24.3' E
Date: 7/04/69
Time:
Water depth: 5981 meters
Location: Abyssal Floor of the Pacific

CORE DATA

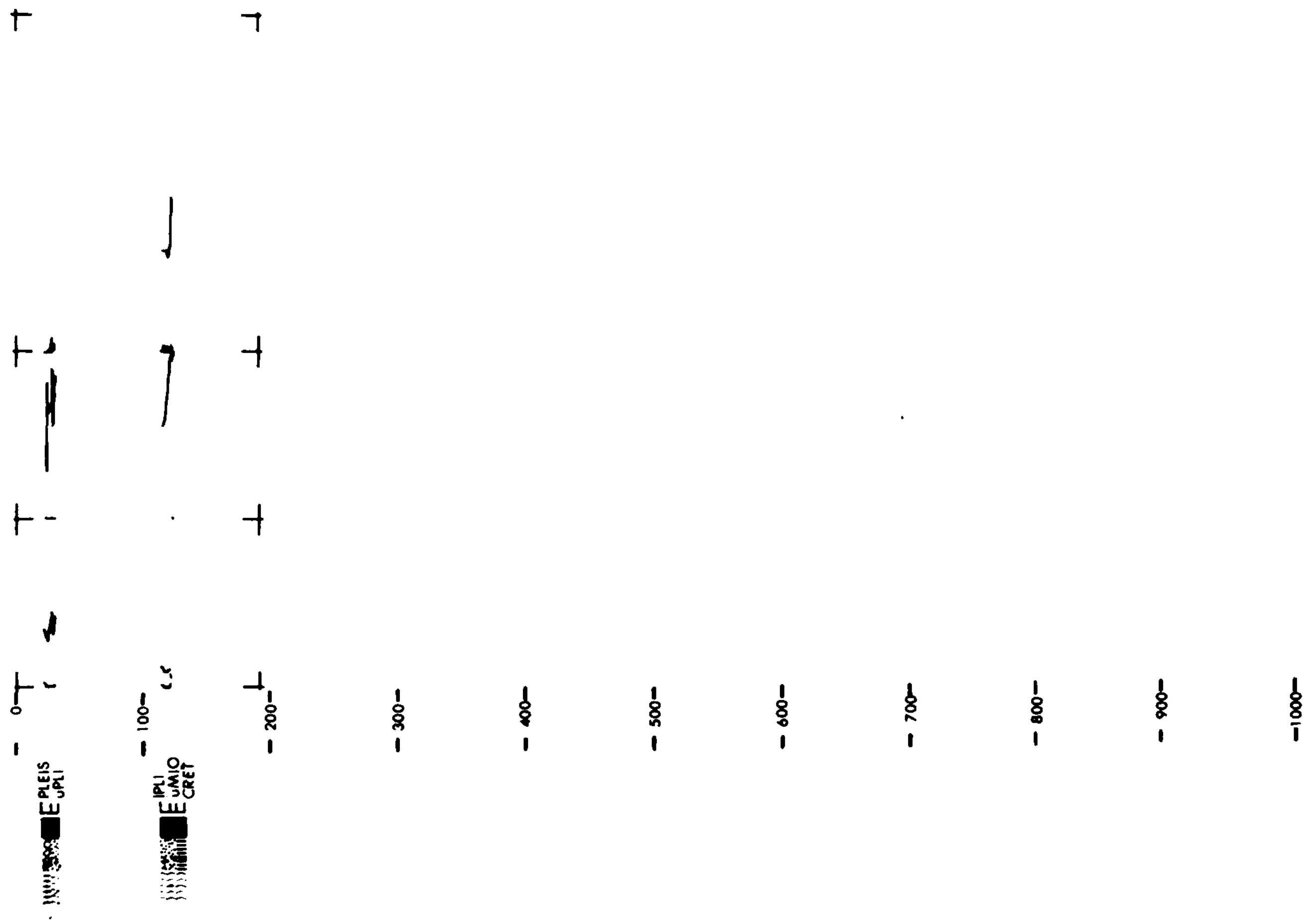
Penetration:	51	51A	
Drilled--	115	113	meters
Cored----	17	15	meters
Total----	132	128	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	3	3	cores
	9.4	11	meters

The Neogene brown clay sequence here is unusually thick, a local condition related to topography. The cores suggest that all or nearly all of this thick sequence is Neogene, with the Pleistocene extending at least to a depth of 32 meters and the Miocene to a depth of 124 meters. Such depositional rates seem much too high for abyssal brown clays. Furthermore, the apparent absence or near-absence of the Paleogene in this deep-water setting appears anomalous and the clays recovered were exceedingly brecciated and disturbed. The authors are not wholly convinced that these are the depths at which these sediments actually occur and suspect that they may represent slumps from higher in the hole. The Cretaceous is represented by cherts and by foraminiferal ooze of Santonian and Cenomanian ages. These sediments represent the top of the upper opaque acoustic unit in this area. Thus, the top of the upper opaque unit here is roughly as old as its base at Site 45.

Interbedded detrital and siliceous sediment.



SITE 51 LEG 6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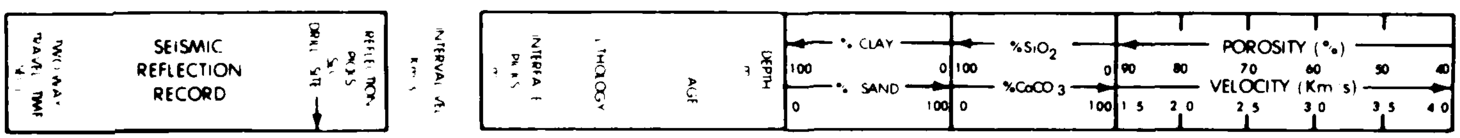
SITE DATA

Position:
Latitude 27°46.3' N
Longitude 147°07.8' E
Date: 7/09/69
Time:
Water depth: 5744 meters
Location: Abyssal Floor of the Pacific

CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 69 meters
Total---- 69 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 10 cores
45 meters

The absence of calcareous fossils, and the poor preservation of Radiolaria in the lower part of this sequence, leaves only very general age information. Brown volcanic-rich clays, containing well-preserved Radiolaria, down to 32 meters are clearly of Cenozoic age. Below this, the clay is nonfossiliferous and assumes a distinctly granular character and more pinkish hue; and is largely a homogenous accumulation of palagonite particles. More normal brown clay appears at 55 to 64 meters and yields Mesozoic types of Radiolaria in the form of chalcedony molds and chalcedonized fragments of spiny saturnalids. Lithified volcanic ash, some of it cherty and radiolarian-bearing, was encountered at 65 meters, in the Cretaceous. The impression gained is that this region is not readily correlated seismically with the remainder of THE CHALLENGER in the Northwest Pacific, and that it probably contains older sediments than does the region around the Shatsky Rise—possibly the oldest sediments in the Pacific.



SITE 52 LEG 6

SITE DATA

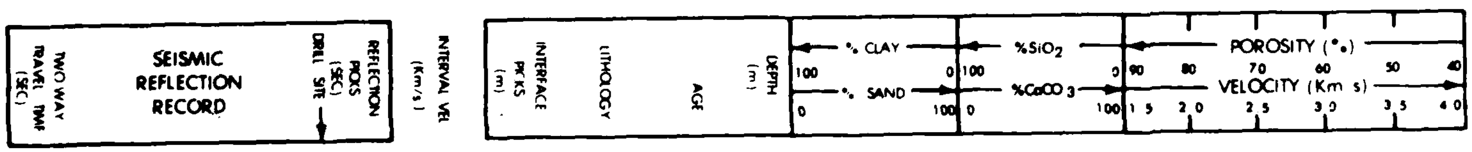
Position:
Latitude 18°02.0' N
Longitude 141°11.5' E
Date: 7/13/69
Time:
Water Depth: 4629 meters
Location: Flank of Iwo Jima Ridge

CORE DATA

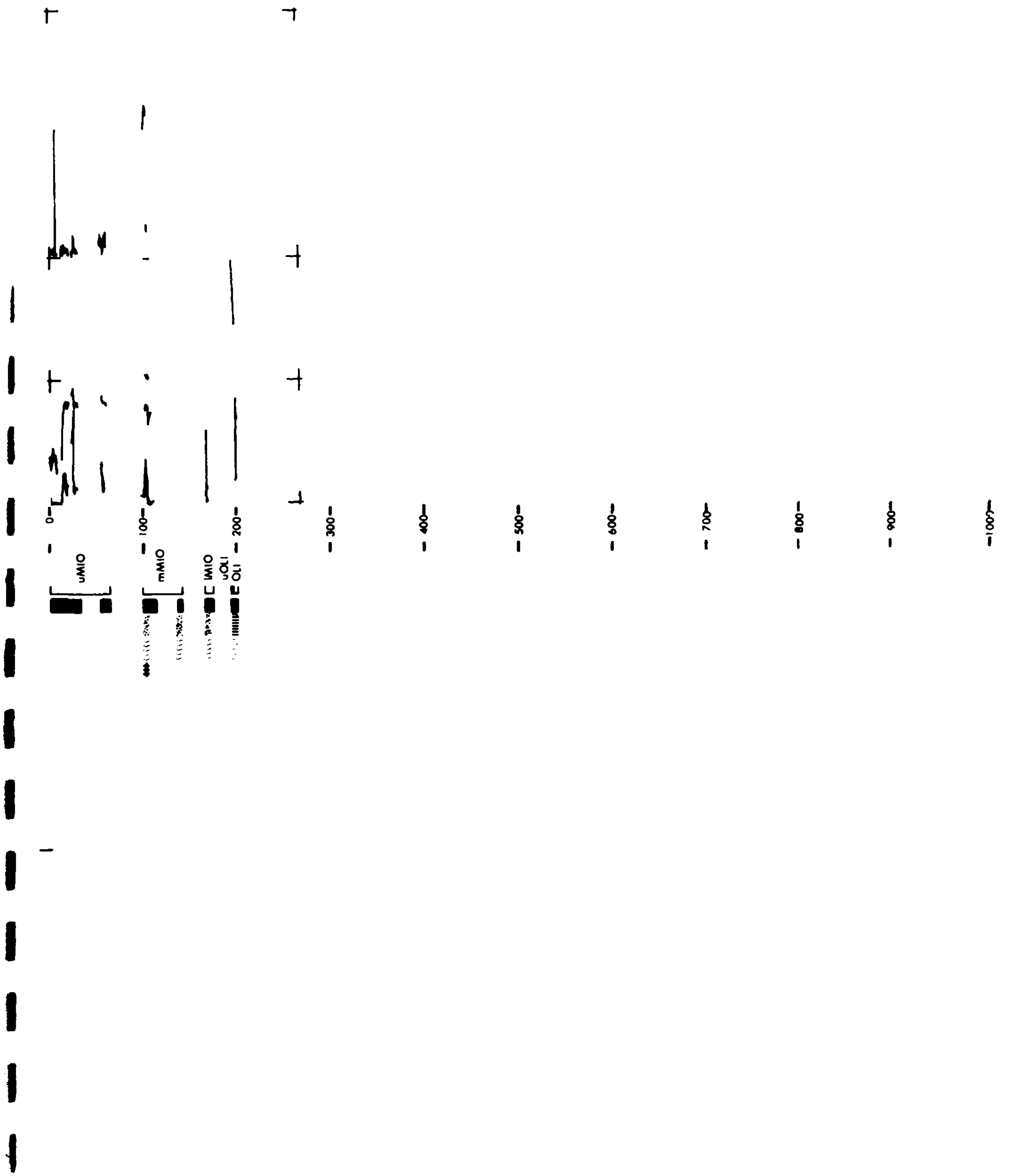
Penetration:	53	53A	53B	
Drilled----	166	35	12	meters
Cored----	35	28	10	meters
Total----	201	62	22	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	8	3	1	cores
	12	26	9	meters

The sediment apron west of the West Mariana Ridge is a sequence of Miocene volcanic ashes, mainly pumice ash of andesitic compositon, with an admixture of the most solution-resistant nannofossils (discoasters). Restriction of thick sediments to one side of the Iwo Jima Ridge suggests that this feature was the source of the ash, and was volcanically active mainly during the Miocene. The sediments are underlain by basaltic flows and pyroclastics with interbedded altered limestones, of Oligocene or Lower Miocene age. This (?) basement seems to correspond to the Eocene-Oligocene Alutom Formation, and the Lower Miocene Umatac Formation of Guam. These are the oldest rocks exposed on Guam, and are volcanic-sedimentary complexes some thousands of feet thick, with no base exposed. The similarity of the sequence to that on Guam and the wide distribution of the 3 to 4 km/sec layer in the Philippine Sea, suggest that this volcanism was not a localized phenomena of the island arc, but was regionally widespread.

Calcareous sediment; rarely nannofossil rich.



SITE 53 LEG 6



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SITE DATA

Position:
- Latitude 15°36.6' N
- Longitude 140°18.1' E

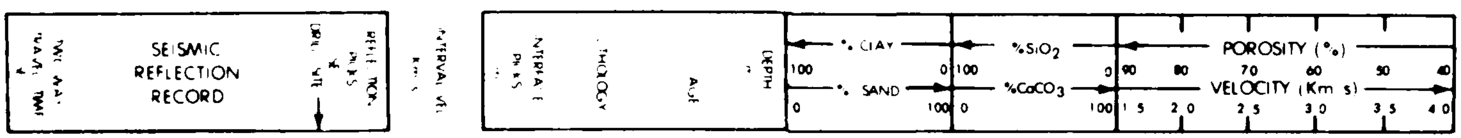
Date: 7/17/69
Time:
Water depth: 4990 meters
Location: Flank of Iwo Jima Ridge

CORE DATA

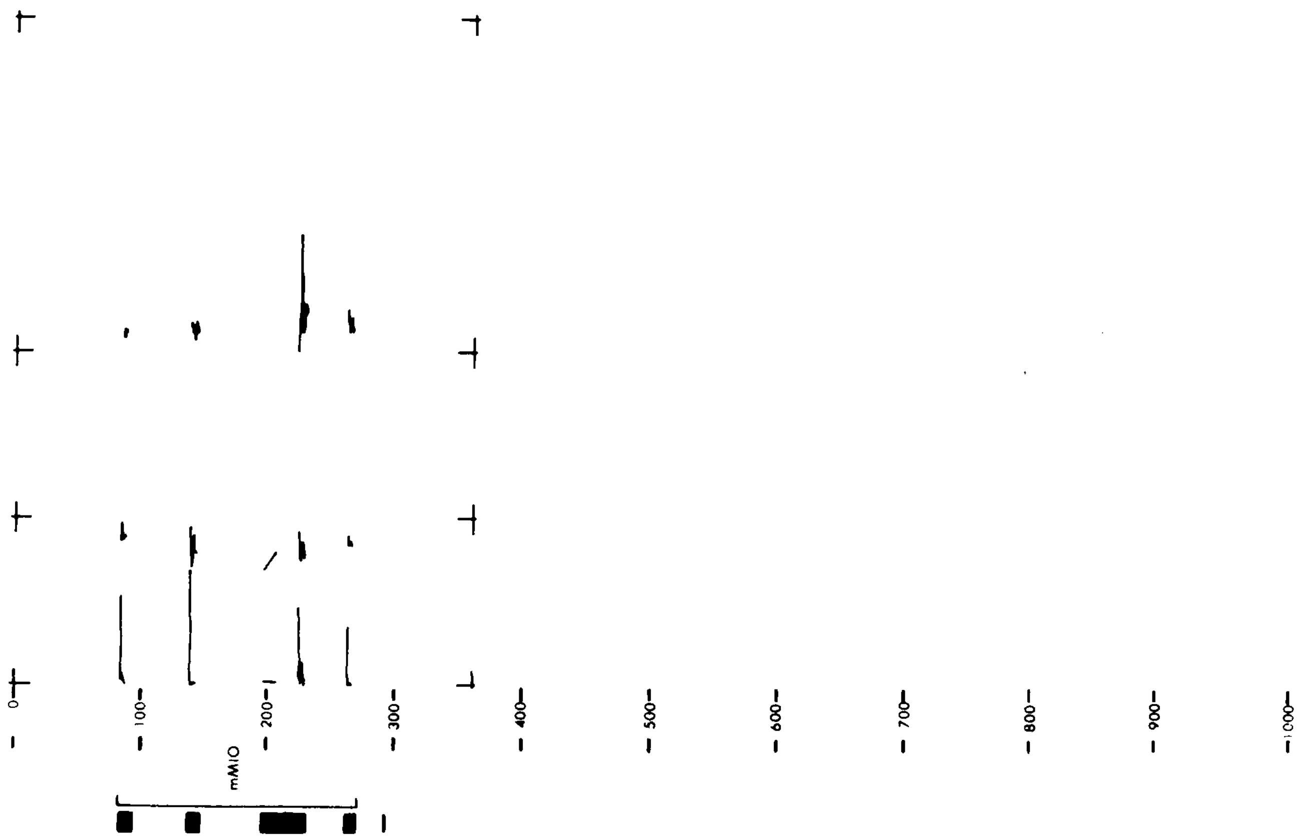
Penetration:
- Drilled-- 218 meters
- Cored---- 76 meters
- Total---- 294 meters

Recovery:
- Basement- 2 cores, 1.5 meters
- Total---- 9 cores, 28 meters

The sediments consist mainly of Miocene volcanic ash. They include some beds of pumice tuff. The composition of the glass ranges from andesitic to basaltic. The occurrence of some graded beds supports the view that some of these ash beds may have been resedimented by turbidity currents. The bulk of the section penetrated is of Middle Miocene age. Although the water depth is similar to that at Site 53, and the sediments are of the same general character, Site 54 shows a much better preservation of calcareous fossils. Foraminifera are common, as are heterococcoliths, whereas at Site 53, the biota was largely reduced to the most solution-resistant discoasters. The sediments are underlain by a basaltic lava flow, with a mantle of basaltic glass breccia. The general history at Site 54 seems to correspond closely to that at Site 53, and at Guam. The eastern Philippine Sea appears to have as geophysical basement a basaltic lava complex with interbedded sediments of Eocene-Oligocene and possibly early Miocene age; and, this is succeeded by mixed andesitic-basaltic pumice tuffs and ashes, erupted from the ridges in Miocene time.



SITE 54 LEG 6



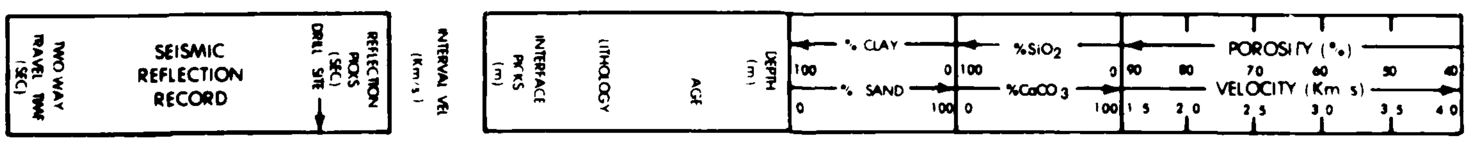
SITE DATA

Position:
  Latitude 9°18.1' N
  Longitude 142°32.1' E
Date: 7/21/69
Time:
Water depth: 2850 meters
Location: Caroline Ridge

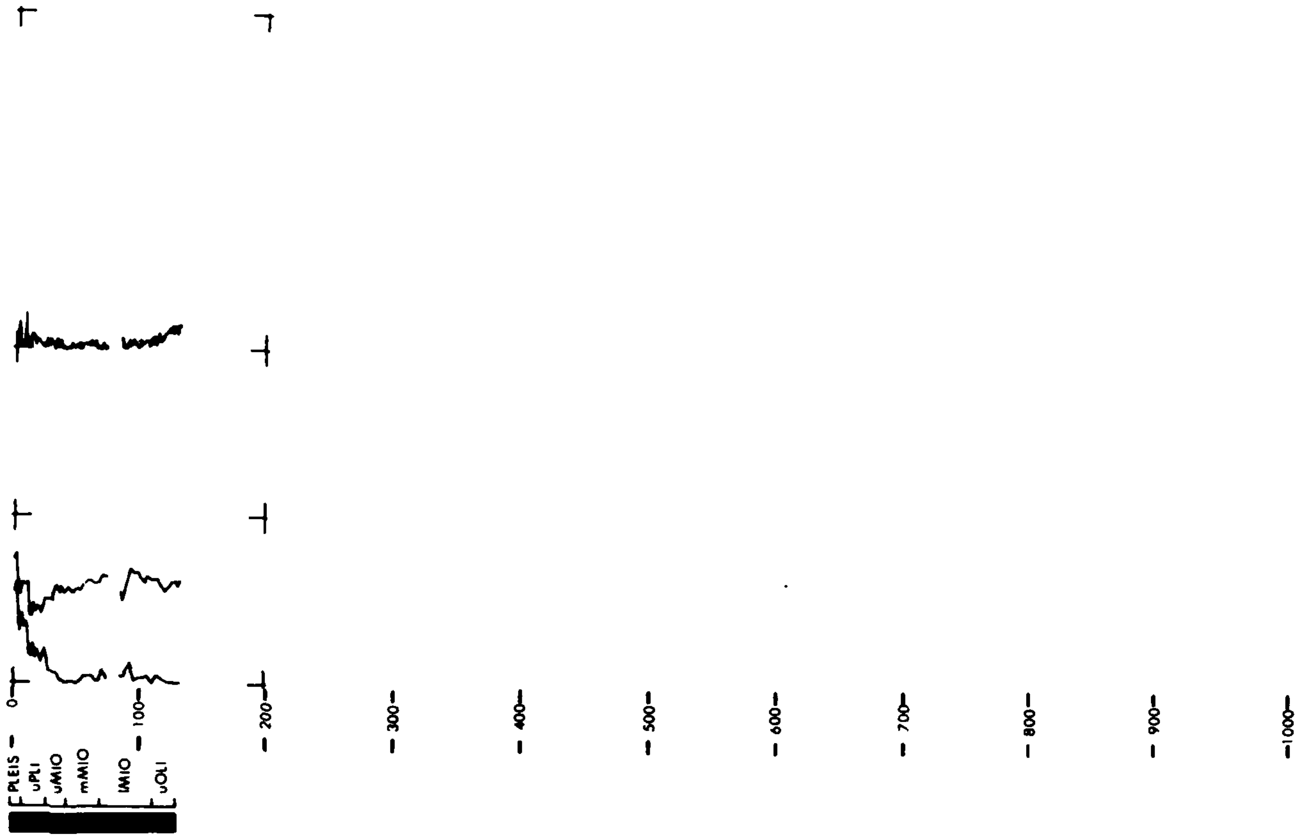
CORE DATA

Penetration:
  Drilled-- 0 meters
  Cored---- 131 meters
  Total---- 131 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 14 cores
  122 meters

Site 55 obtained an almost complete section through the Neogene, and passed barely into the Oligocene (G. ciperoensis zone in the last core catcher) perhaps halfway to the base of the sediments, when the birth of typhoon Viola halted the operation and forced the ship eastward. The sediment encountered is chalk ooze dominated by nannoplankton and containing variable amounts of planktonic foraminifera, Radiolaria, and sponge spicules. This chalk ooze is predominantly white, less commonly very pale brown. The pale brown color is particularly characteristic of chalk ooze containing moderate (10 to 20 per cent) amounts of siliceous microfossils. Sediment in all of the cores was usually in a moderately to highly disturbed condition due to coring.



SITE 55 LEG 6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SITE DATA

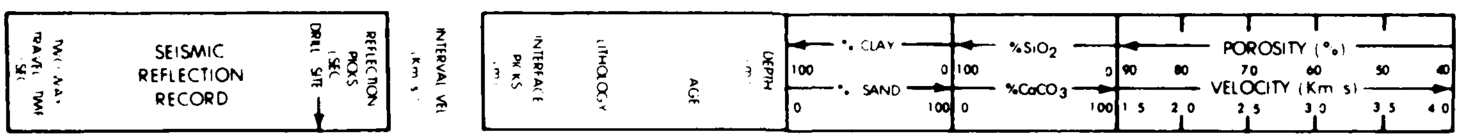
Position:
- Latitude 8° 22.4' N
- Longitude 143° 33.6' E

Date: 7/23/69
Time:
Water Depth: 2508 meters
Location: Caroline Ridge

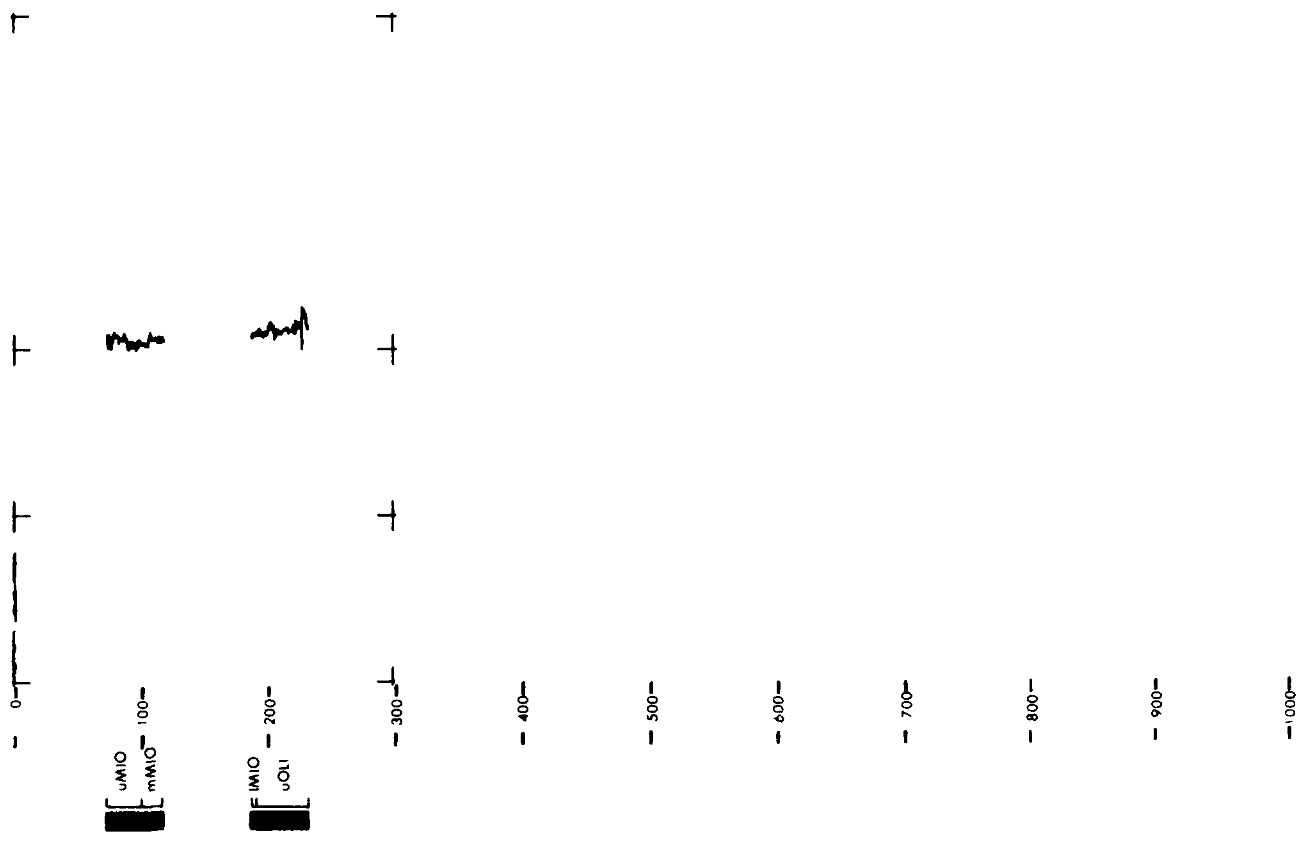
CORE DATA

Penetration:	56	56 A	56 B	
Drilled--	0	0	178	meters
Cored----	0	0	92	meters
Total----	0	0	270	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	0	0	10	cores
	0	0	88	meters

The Neogene stratigraphic sequence at Site 56 closely resembles that at Site 55, consisting of nannoplankton-foraminiferal oozes, with evidence of ash falls in the Early Miocene. The lower sequence, which was not penetrated at Site 55, consists of Upper Oligocene nannofossil oozes and chalks with Radiolaria, foraminifera and some ash. Some of the chalks are slightly cemented. The massive reflector at the base of the sediments was too hard for the worn bit.



SITE 56 LEG 6



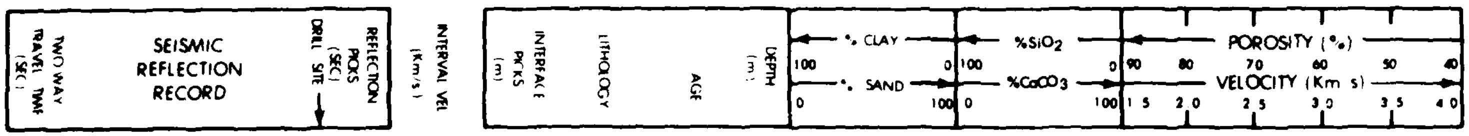
SITE DATA

Position:
Latitude 8°24.9' N
Longitude 143°32.0' E
Date: 7/25/69
Time:
Water Depth: 3300 meters
Location: Caroline Ridge

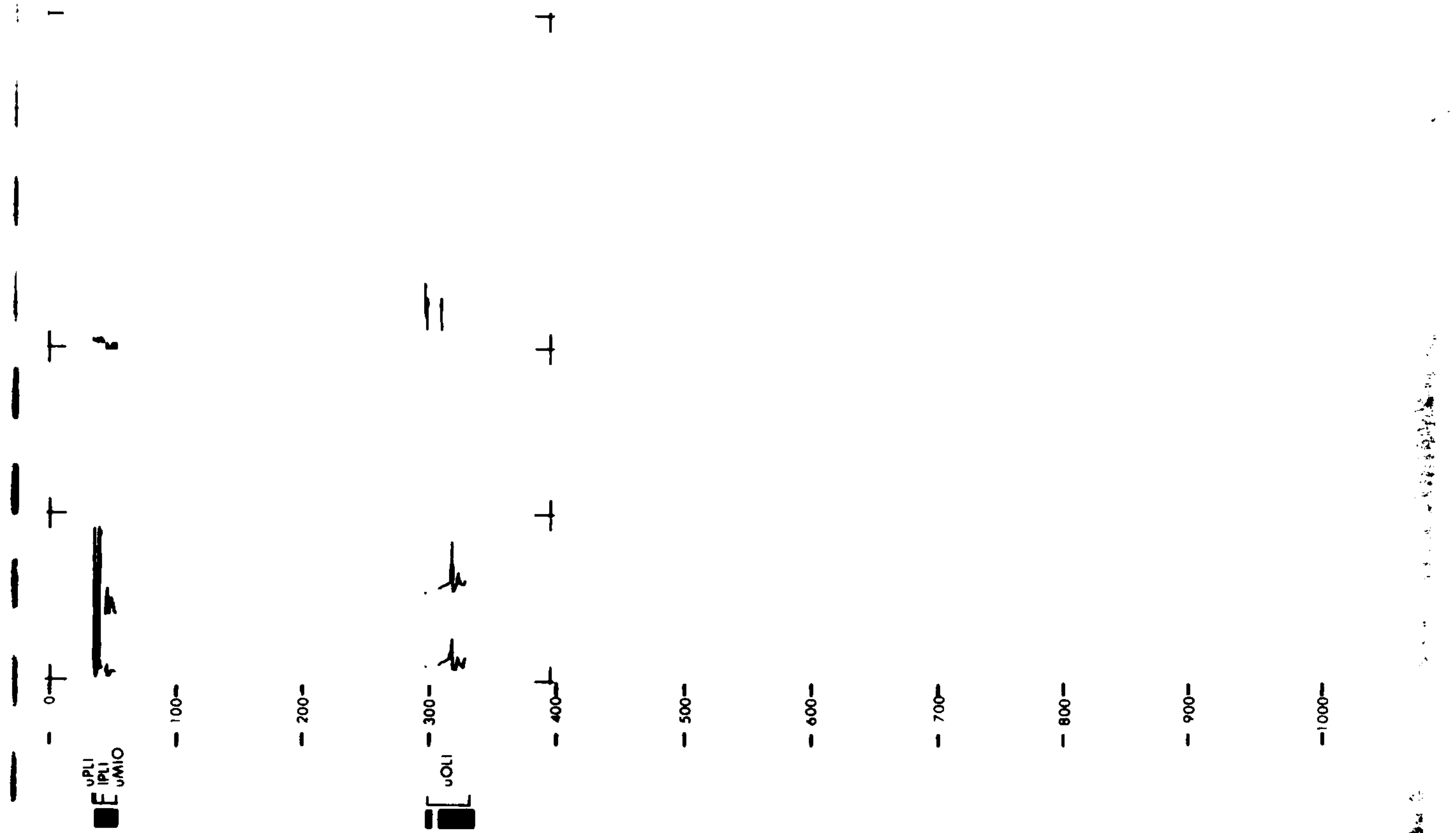
CORE DATA

Penetration:	57	57A	57B	
Drilled--	323	298	35	meters
Cored----	12	31	9	meters
Total----	335	329	44	meters
Recovery:				
Basement-	2	1	0	cores
	2.8	.2	0	meters
Total----	3	4	1	cores
	6.7	23	9	meters

The massive opaque reflector at the base of the sediments is a doleritic basalt flow, emplaced before the end of the Oligocene. The coarse (doleritic) texture of the basalt shows it to be either a sill or a very thick flow ("lava lake"). The unaltered nature of the overlying sediments, however, eliminates the likelihood of its having been a sill. The lack of a chill zone at the top of the basalt is surprising, especially inasmuch as there is no sign of weathering and erosion. This might be explained as a result of the spalling-off of a glassy chill crust, an explanation which receives support from the fact that several loose pieces of basalt (also fresh) were recovered from the sediment above the contact. The north flank of the Caroline Ridge thus appears to have a young basaltic floor, like the Philippine Sea (Sites 53, 54), and contrasts sharply with the much older Pacific Ocean floor farther north. It is suggested that this younger basaltic floor may be true oceanic basement, but this cannot be proven. Basaltic surfaces at sea are not necessarily topographically rough but can be smooth and flat. The relief associated with juvenile crust near the Mid-Oceanic Ridge results from tectonic displacements characteristic of setting, rather than from extrusion of lava on the sea floor.



SITE 57 LEG 6



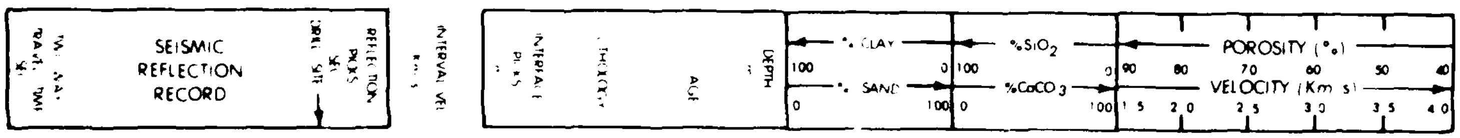
SITE DATA

Position:
Latitude 9°14.1' N
Longitude 144°25.1' E
Date: 7/28/69
Time:
Water Depth: 4503 meters
Location: North flank of Caroline Ridge

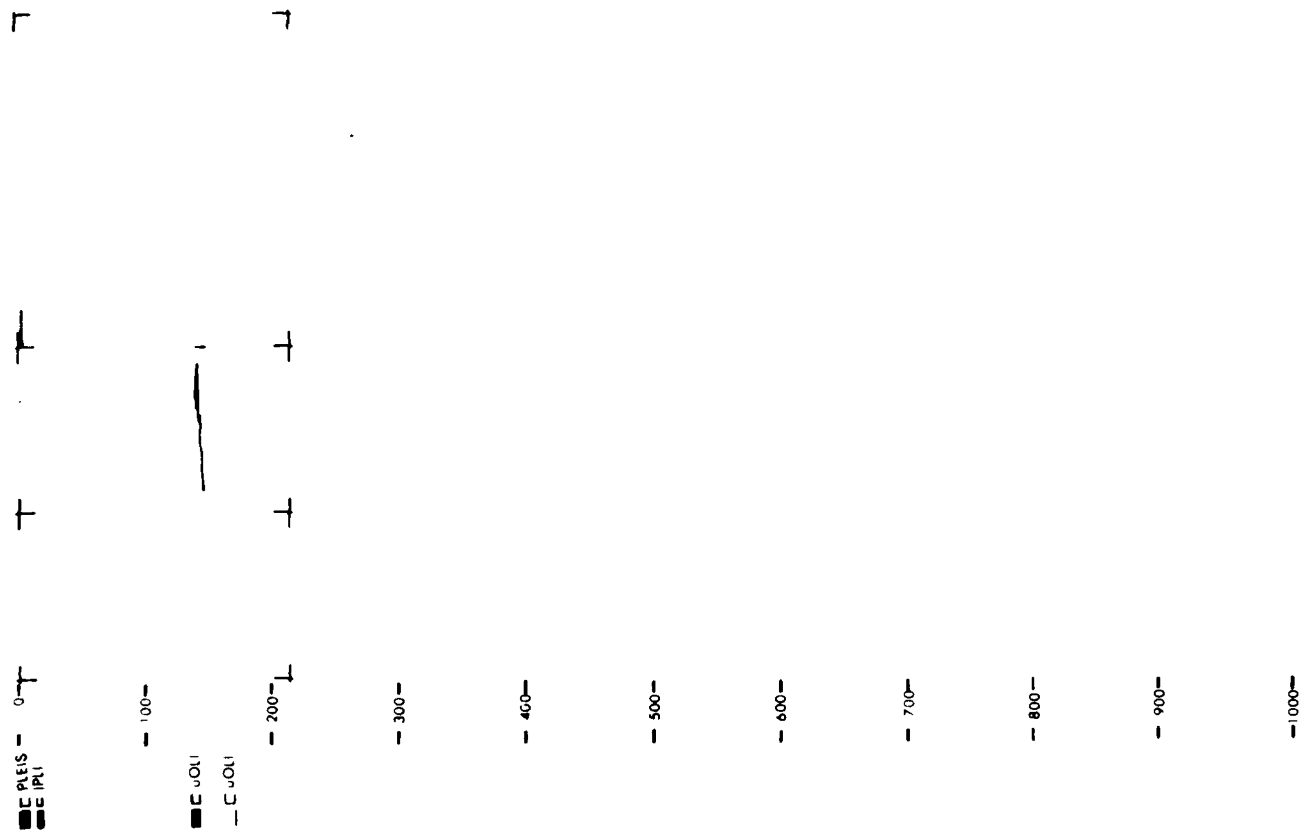
CORE DATA

Penetration:	58	58A	58B	
Drilled--	15	163	137	meters
Cored----	5	10	6	meters
Total----	20	173	143	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	1	3	1	cores
	.3	5	9	meters

The oceanic crust at Site 58 appears to be closely allied to that of the Caroline Ridge. A smooth, hard basement is overlain by Oligo-Miocene sediments. While no core was recovered from the basement, its drilling characteristics and the presence of fresh chips of diabasic basalt in the bumper sub make it extremely probably that the basement is very much like that at Site 57. An unusual feature of the sediments at Site 58 is the admixture of shallow water clasts. The pelagic sediments are nannoplankton oozes with an admixture of diatoms and Radiolaria. The admixed clasts consist of granules and pebbles of vesicular basalt, glass, skeletal material and lithified limestone. The larger foraminifera are mainly of late Oligocene to Miocene age, and none are older. The clasts occur partly in well-sorted sands, partly as pebbles dispersed in ooze matrix. Site 58 lies in a branched submarine valley extending to the flanks of Faraulep Atoll, Gaferut Island, and a number of banks which are of joint volcanic reef growth origin. Presumably this valley serves as an avenue for turbidity currents and other currents, and as an avenue for sediment transport.



SITE 58 LEG 6



SITE DATA

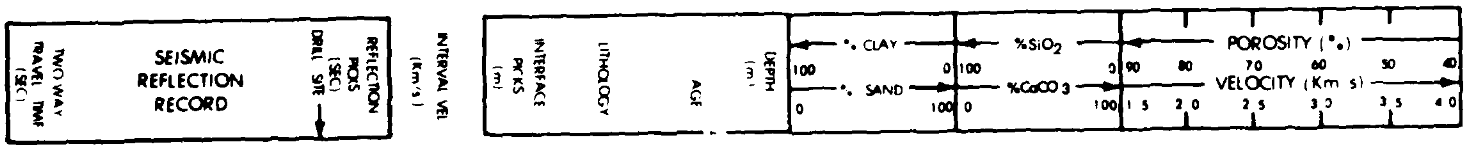
Position:
Latitude 11°46.8'N
Longitude 147°34.9'E
Date: 7/31/69
Time:
Water Depth: 5554 meters
Location: Abyssal Floor; east of Mariana Trench

CORE DATA

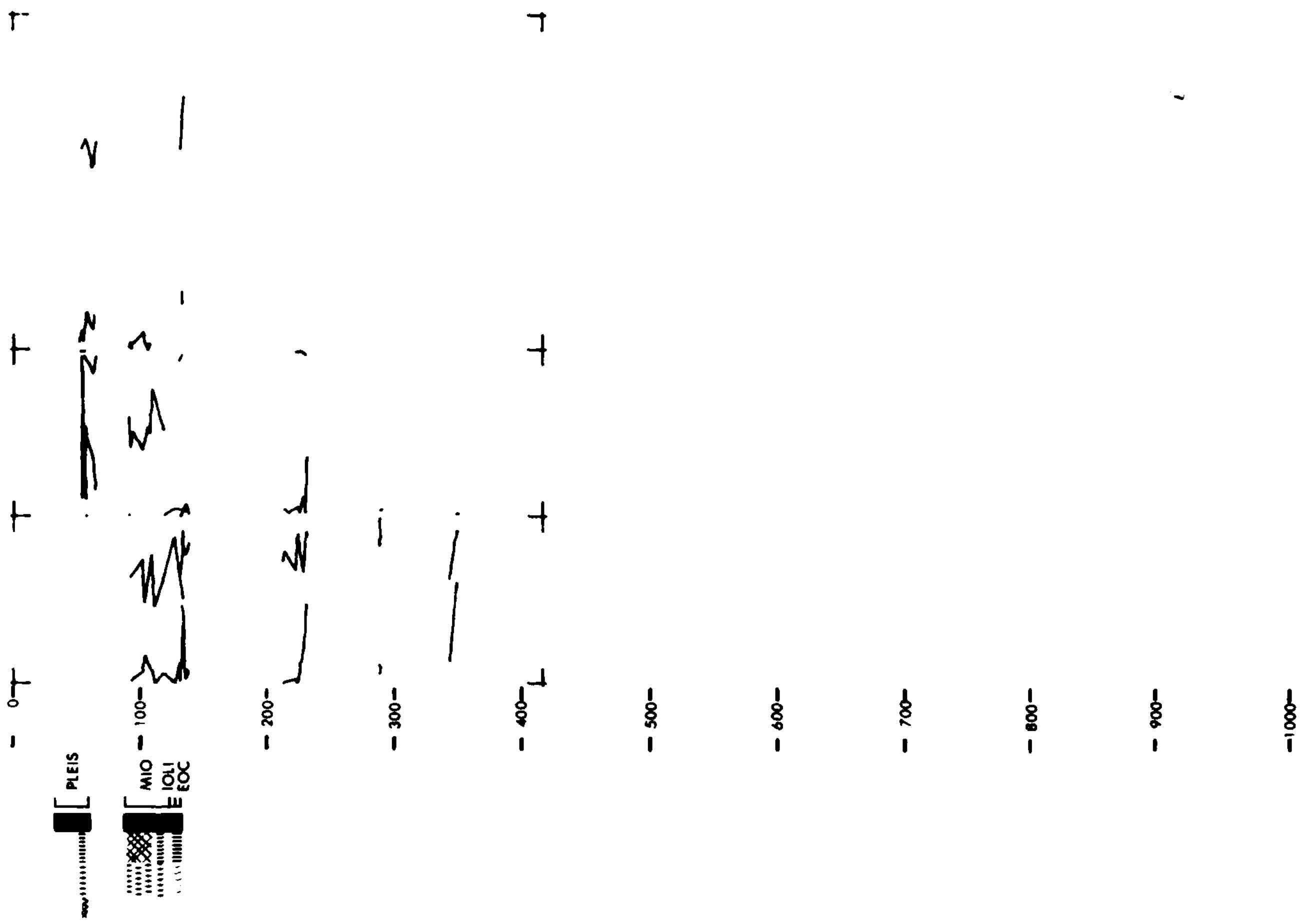
	59	59A	59B	
Penetration:				
Drilled----	121	34	89	meters
Cored----	1	28	46	meters
Total----	122	61	135	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	1	3	6	cores
	0	3	19	meters

Site 59 is located on old Pacific crust; the upper transparent layer is mainly Neogene; the Eocene and Paleocene are present in a very condensed section within the third core of Hole 59.2 (of which only 1.2 meters were recovered), and the top of the Cretaceous also lies within this core. The Paleocene contains some carbonate, while the Cretaceous is devoid of calcareous nannofossils. Chert occurs in the Cretaceous, but it cannot be certain whether it is present or absent in the Eocene-Paleocene section. The identification of chert rests on the presence of Cretaceous-type Radiolaria, which are not as yet pinned down more precisely to stages. Drilling at this site thus penetrated a succession somewhat similar to that encountered at Sites 45, 46, 51 and 52, and which was formed on a crust that probably dates back to Jurassic time. The fracture zone which was crossed southwest of Site 59 is most likely the boundary between the young and old crust in this area.

Pleistocene siliceous sediments; diatom rich. Earlier sediment occasionally radiolaria rich.



SITE 59 LEG 6



SITE DATA

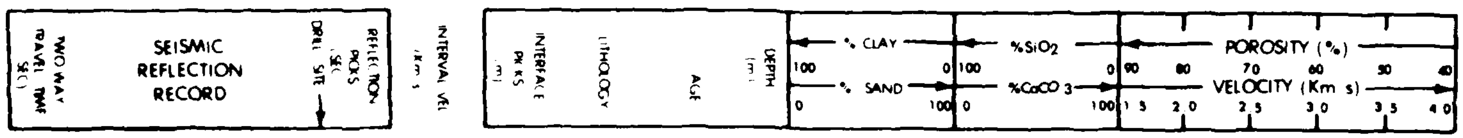
Position:
Latitude 13°40.0'N
Longitude 145°41.0'E
Date: 8/ 03/ 69
Time:
Water depth: 3717 meters
Location: Marianna Trench

CORE DATA

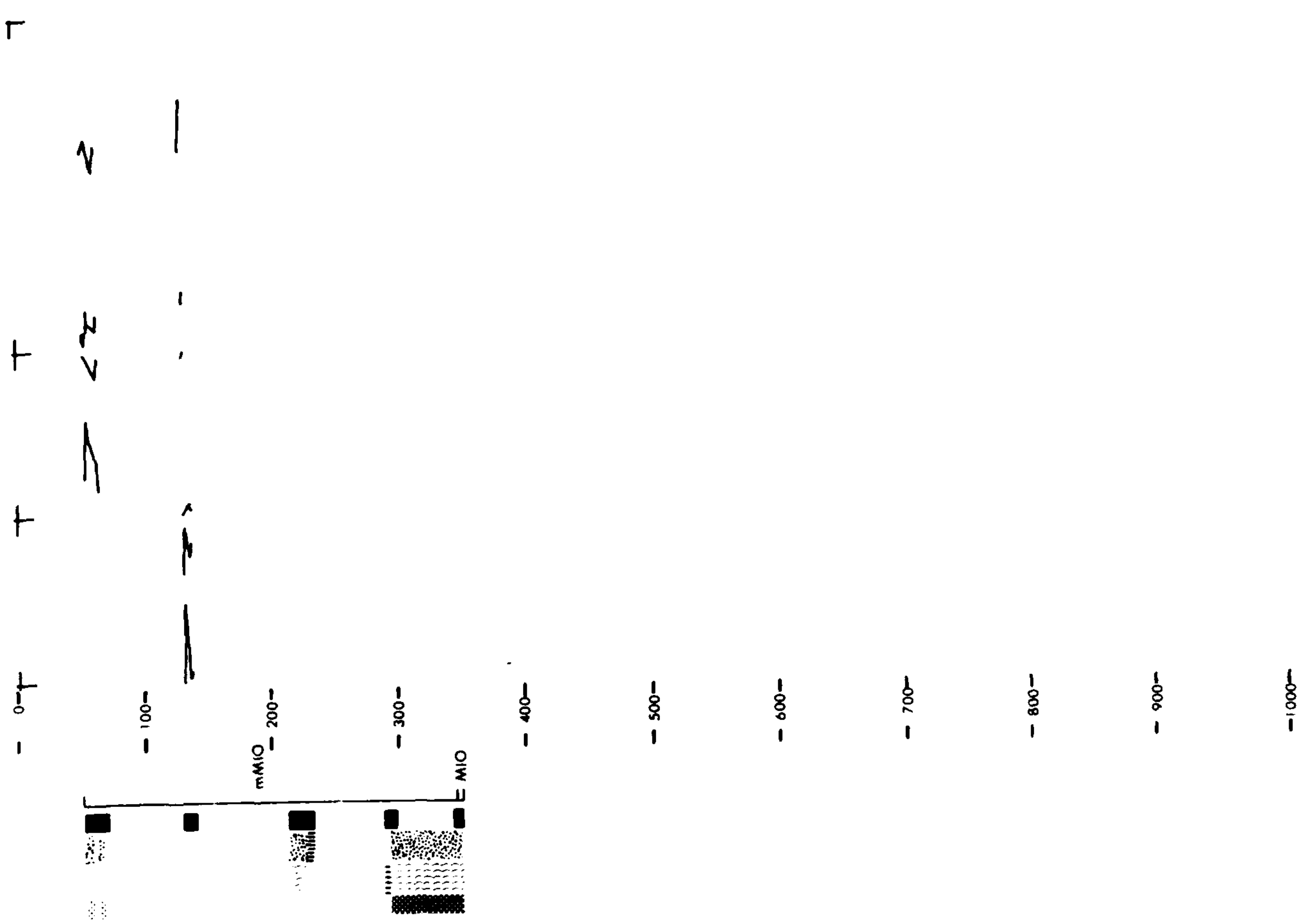
Penetration:
Drilled-- 227 meters
Cored---- 121 meters
Total---- 348 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 9 cores
35 meters

Guam has on its east, a thick apron of Miocene pyroclastics. This forms a compliment to the Miocene pyroclastic apron shed westward from the Iwo Jima Ridge, which was drilled at Sites 53 and 54. For reasons not clear, but possibly related to depth of burial, the pyroclastics in the lower part of Hole 60.0 are more consolidated than are those drilled at Sites 53 and 54. The unconformity suggested by the Argo's profiler record and the Challenger profiles was probably penetrated, without a marked change in rock type or age. The sediments cored show no suggestion of a shallow-water eipsode, nor of resedimentation of carbonates from shallow water. Thus, comparatively deep water existed here at least since the end of Early Miocene time.

Calcareous sediments occasionally nannofossil rich. One thin layer of calcareous sediment in the middle Miocene.



SITE 60 LEG 6



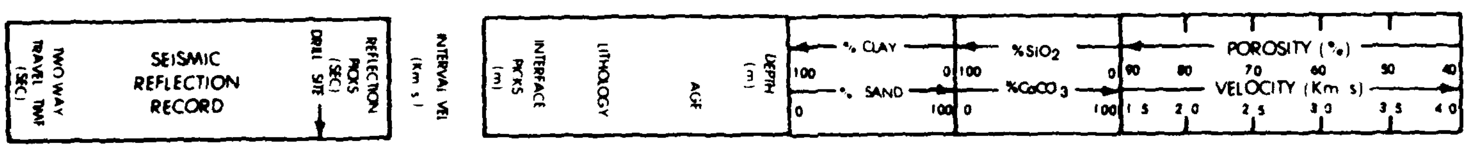
SITE DATA

Position:
  Latitude 12° 05.0' N
  Longitude 147° 03.7' E
Date: 8/09/69
Time:
Water depth: 5570 meters
Location: Carolina Ridge

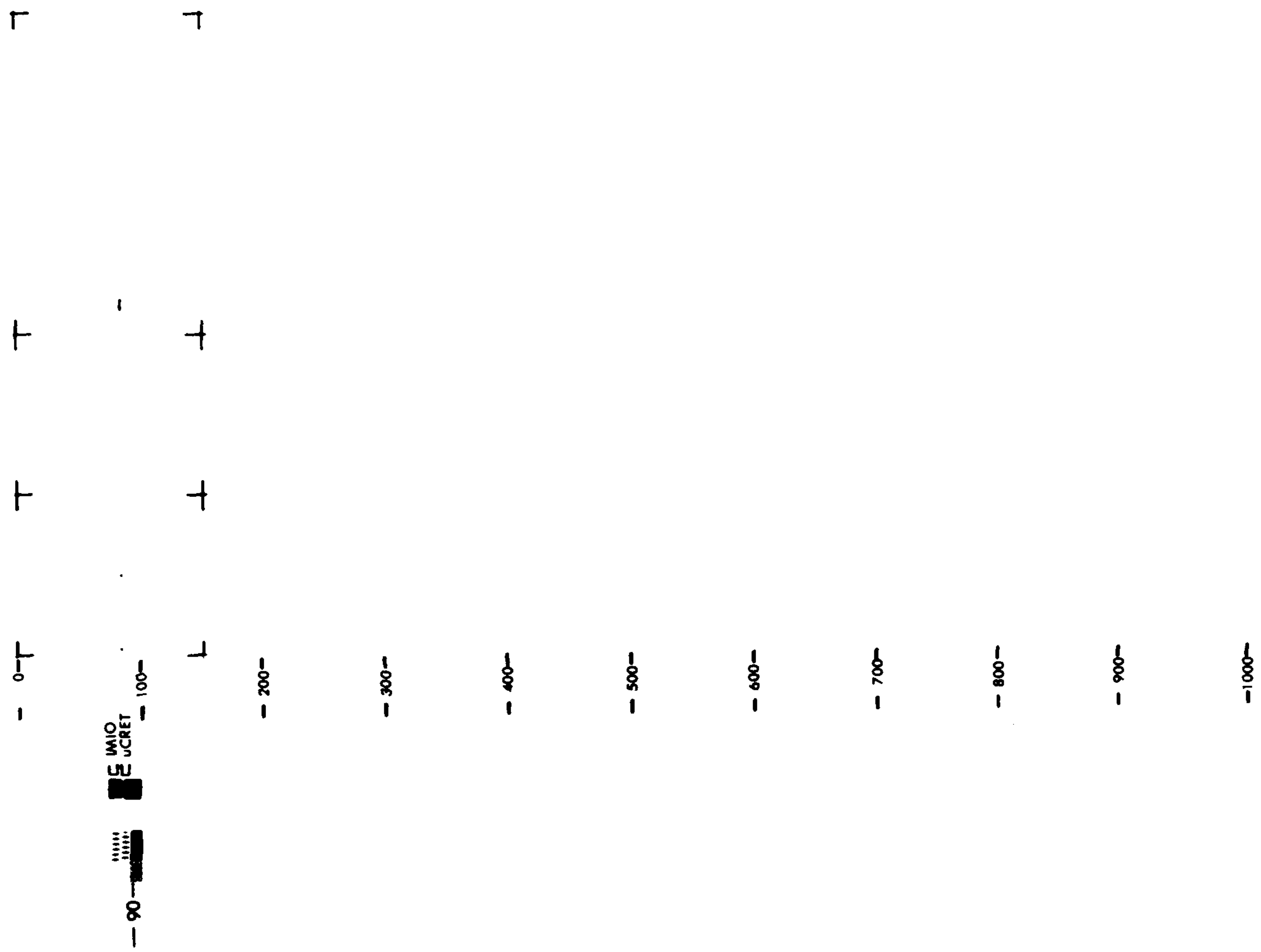
CORE DATA

Penetration:	61	61 A	
Drilled--	88	86	meters
Cored----	13	13	meters
Total---	101	99	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	2	2	cores
	3	3	meters

Soft Neogene sediments, including brown Lower Miocene radiorian clays, overlie Upper Cretaceous cristobalitic mudstones associated with tuff, and minor chert which rests on (and may be interbedded with) amygdaloidal basalt. The lowest seismic reflector, shown on air-gun records at about 0.135 second, was not reached; and between 30 and 100 meters of sediments may lie beneath the basalts in which the holes bottomed.



SITE 61 LEG 7



SITE DATA

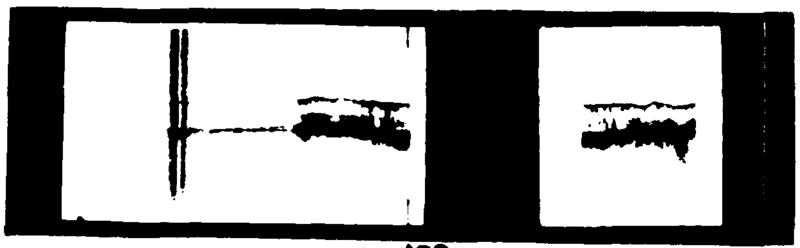
Position:
Latitude 1° 52.2' N
Longitude 141° 56.3' E
Date: 08 / 15/ 69
Time: 1114 Z
Water depth: 2602 meters
Location: Pacific Basin

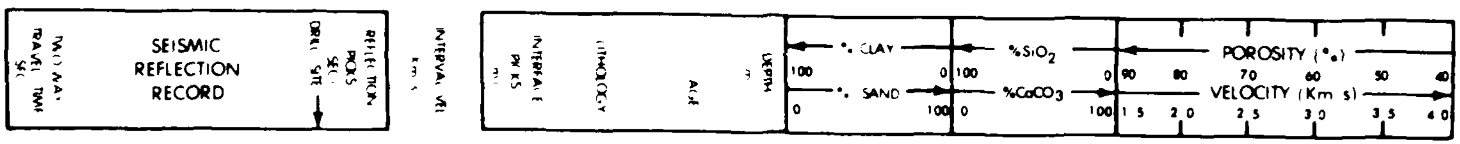
CORE DATA

Penetration:	62	62 A	
Drilled--	523	13	meters
Cored----	58	345	meters
Total----	581	358	meters
Recovery:			
Basement-	1	0	cores
	.3	0	meters
Total----	8	38	cores
	38	311	meters

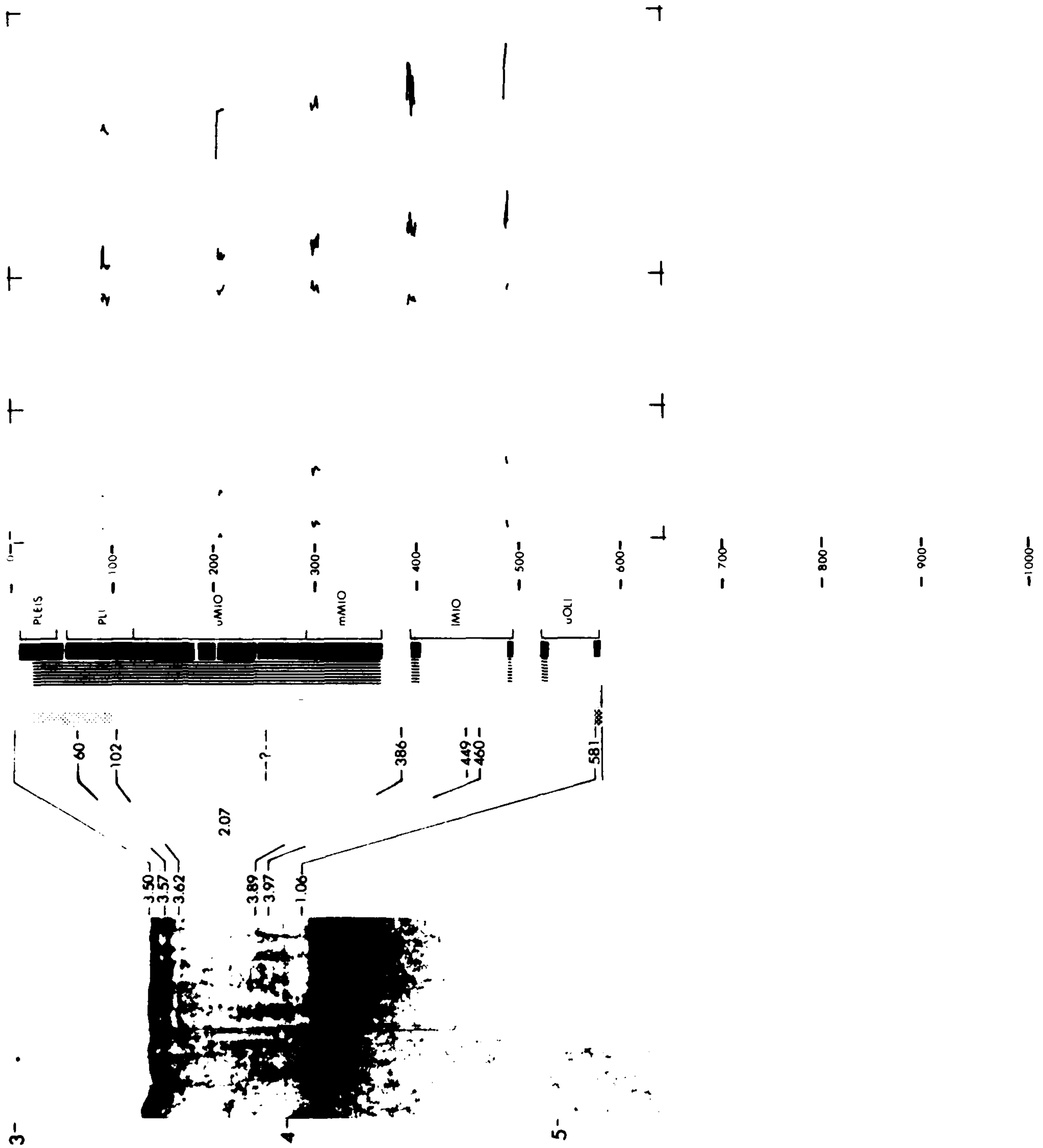
A virtually uninterrupted sequence of upper Oligocene through Quaternary Chalks and chalk oozes rich in nannofossils, foraminifers, and radiolarians, overlies intrusive basalt containing middle Oligocene chalk Xenoliths. Nearly continuous cores from the Quaternary through the middle Miocene provide the basis for very detailed biostratigraphic zonation and correlation. Average rates of accumulation were about 20 m/m.y. The basaltic basement is nearly the same as, or perhaps a little older than the basement reached during Leg 6 on the north side of Caroline Ridge, at Sites 56 and 57.

Calcareous sediment nannofossil rich.





SITE 62 LEG 7

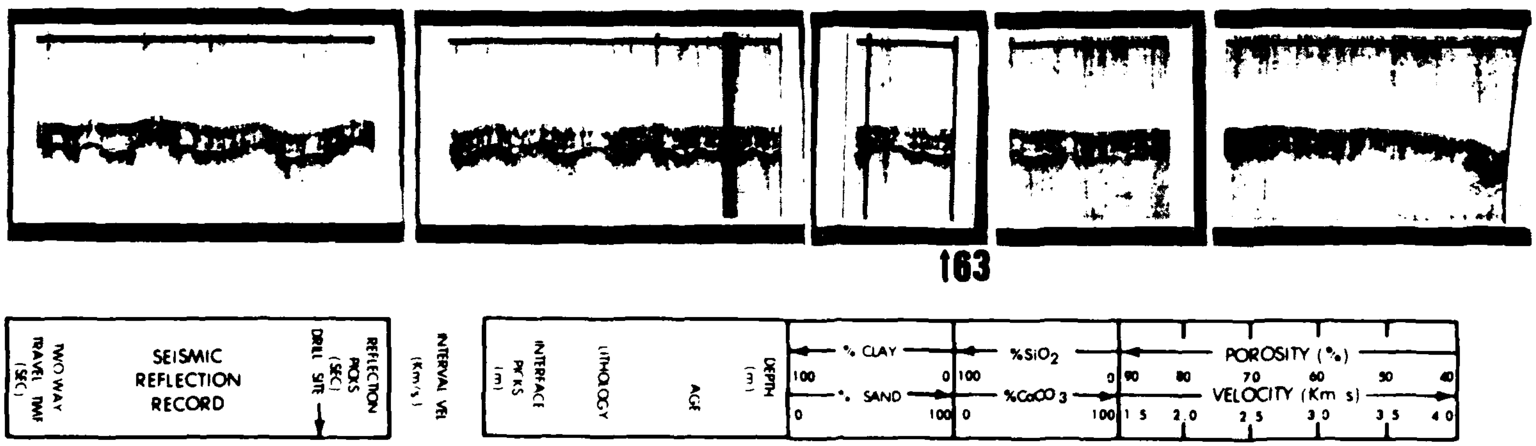


0
100
200
300
400
500
600
700
800
900
1000
PLEIS
PLI
uMIO
mMIO
lMIO
uOLI
60
102
?
386
449
460
581
2.07
3.50
3.57
3.62
3.89
3.97
1.06
3
4
5

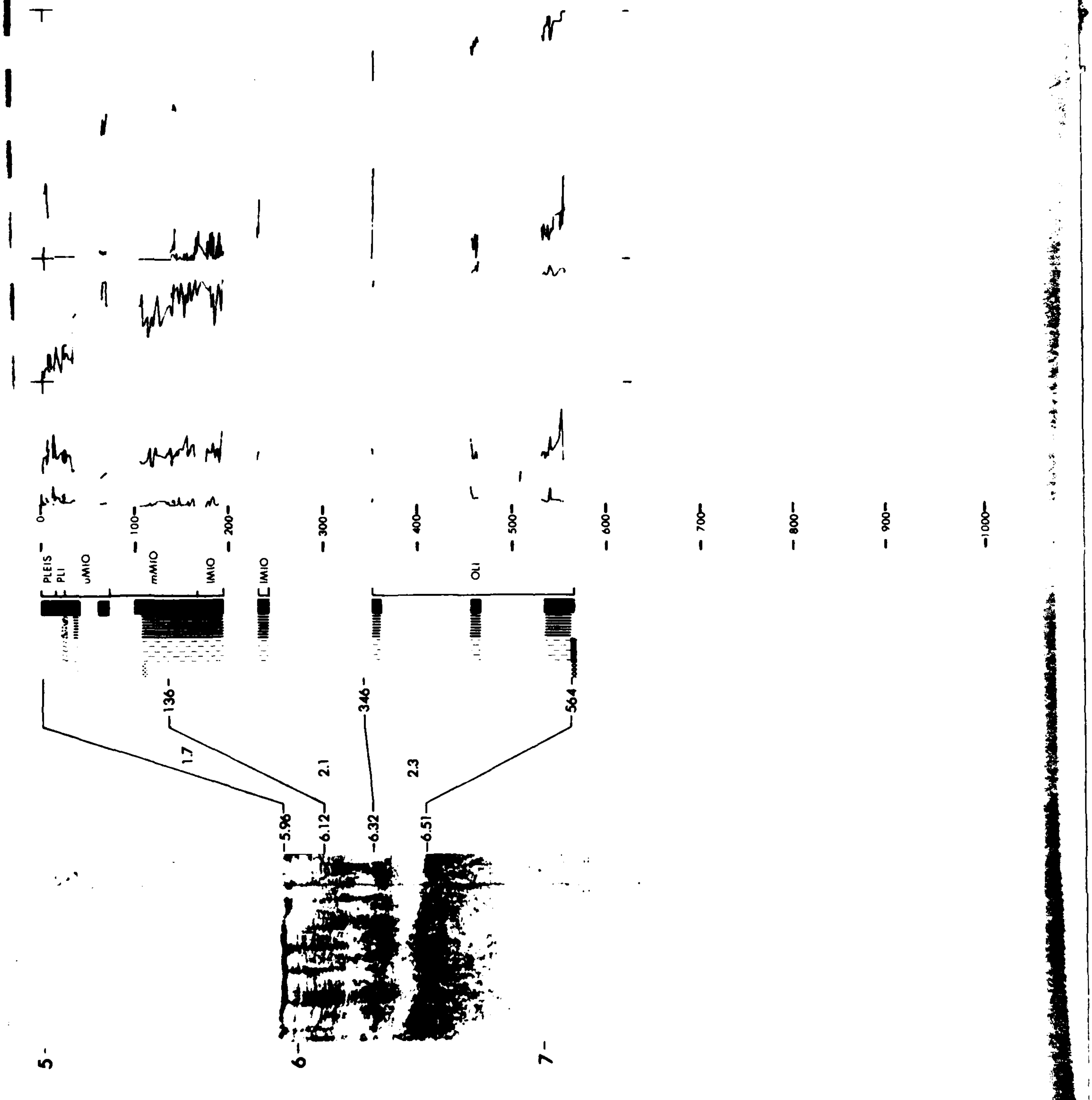
SITE DATA	
Position:	
Latitude	0°50.1'N
Longitude	147°53.4'E
Date: 08/23/69	
Time: 1803 Z	
Water Depth: 4486 meters	
Location: Eauripik Ridge	

CORE DATA				
Penetration:	63	63A	63B	
Drilled--	480	63	41	meters
Cored----	86	130	28	meters
Total----	566	193	39	meters
Recovery:				
Basement-	2	0	0	cores
	3.7	0	0	meters
Total----	11	14	3	cores
	61	90	21	meters

A nearly complete section, from middle Oligocene to Quaternary, uncomformably overlies basalt containing middle Oligocene chalk xenoliths. The sediments consist of chalk and chalk ooze in the Oligocene and Miocene, and marl ooze and calcareous clay in the Pliocene and Quaternary. The rate of accumulation was about 20m/m.y. up until near the end of the Miocene, and since then has slowed to about 7m/m.Y.



SITE 63 LEG 7



0
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600
700
800
900
1000
PLEIS
PLI
uMIO
mMIO
lMIO
lMIO
OLI
136
346
564
1.7
2.1
2.3
5.96
6.12
6.32
6.51
5
6
7

SITE DATA

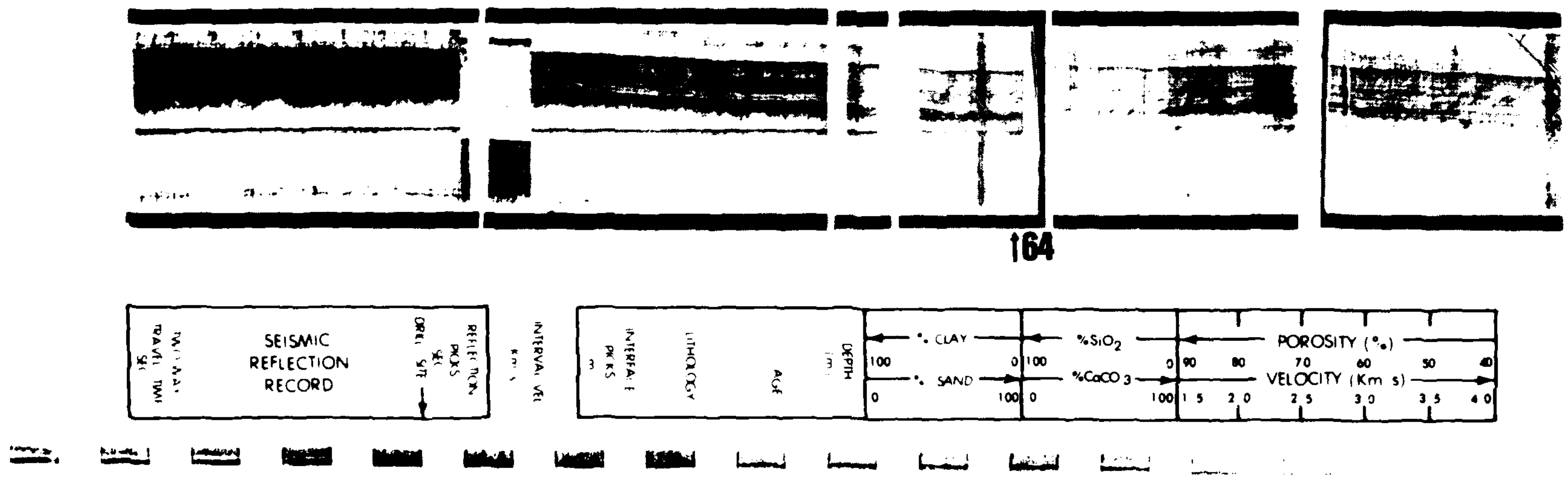
Position:
Latitude 1° 44.5' S
Longitude 158° 36.6' E
Date: 08 / 31/ 69
Time: 0745 Z
Water depth: 2060 meters
Location: Ontong Java Plateau

CORE DATA

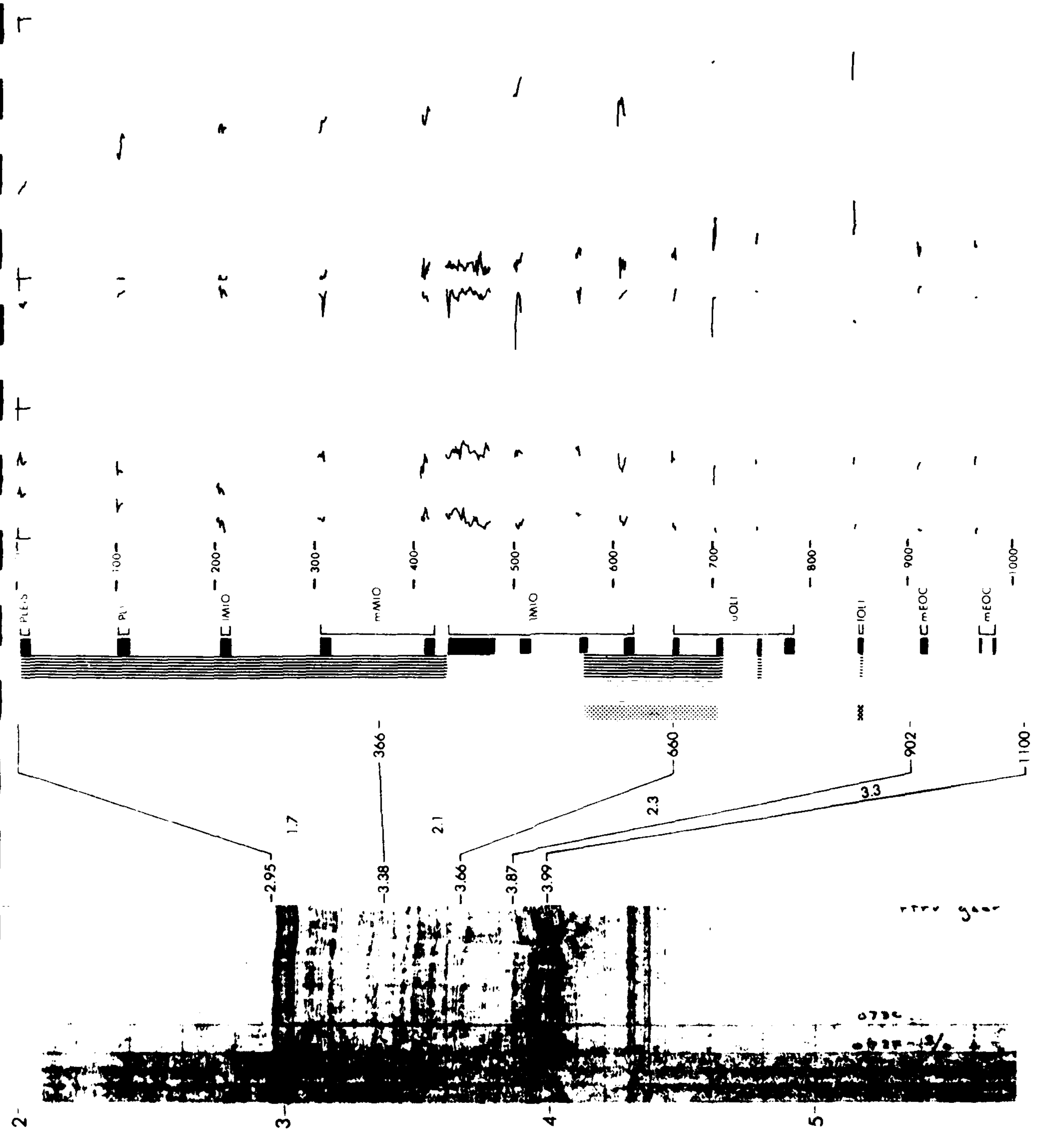
Penetration:	64	64 A	
Drilled--	772	918	meters
Cored----	81	67	meters
Total----	853	985	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	10	11	cores
	75	68	meters

The drill penetrated an apparently uninterrupted sequence of highly calcareous pelagic sediments ranging in age from late middle Eocene to recent. The moderately smooth basal seimic reflector was not reached, but probably was less than 150 meters below the bit. The many reflectors traceable on reflection profiles in this region are due mainly to alternation of slightly more and less well indurated layers. Diagenesis caused greater induration and compaction, progressive loss of color, and increasing silicification and calcite solution and recrystallization. Rates of accumulation averaged about 23 m/m.Y.

Calcareous sediment in lower Miocene foraminifera rich, and in upper Oligocene nannofossil rich.



SITE 64 LEG 7


100
200
300
400
500
600
700
800
900
1000
PLE-S
PL
lMIO
mMIO
lMIO
uOLI
lOLI
mEOC
mEOC
366
660
902
1100
1.7
2.1
2.3
3.3
2.95
3.38
3.66
3.87
3.99
2
3
4
5

SITE DATA

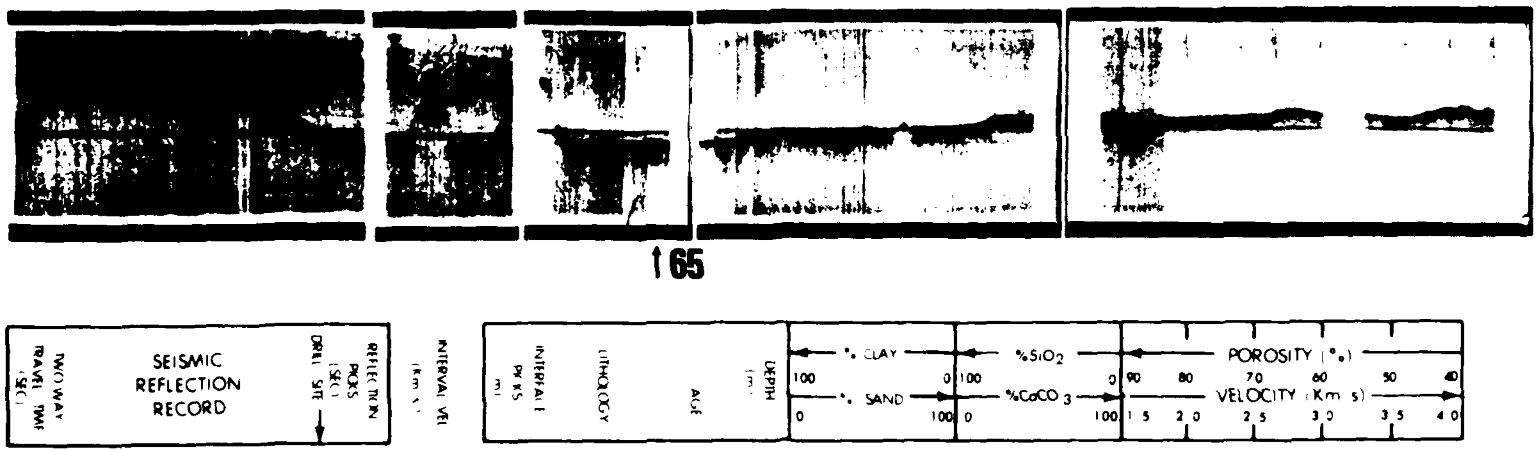
Position:
Latitude 4° 21.2' N
Longitude 176° 59.1' E
Date: 09/11/69
Time: 1456 Z
Water depth: 6142 meters
Location: Central Basin

CORE DATA

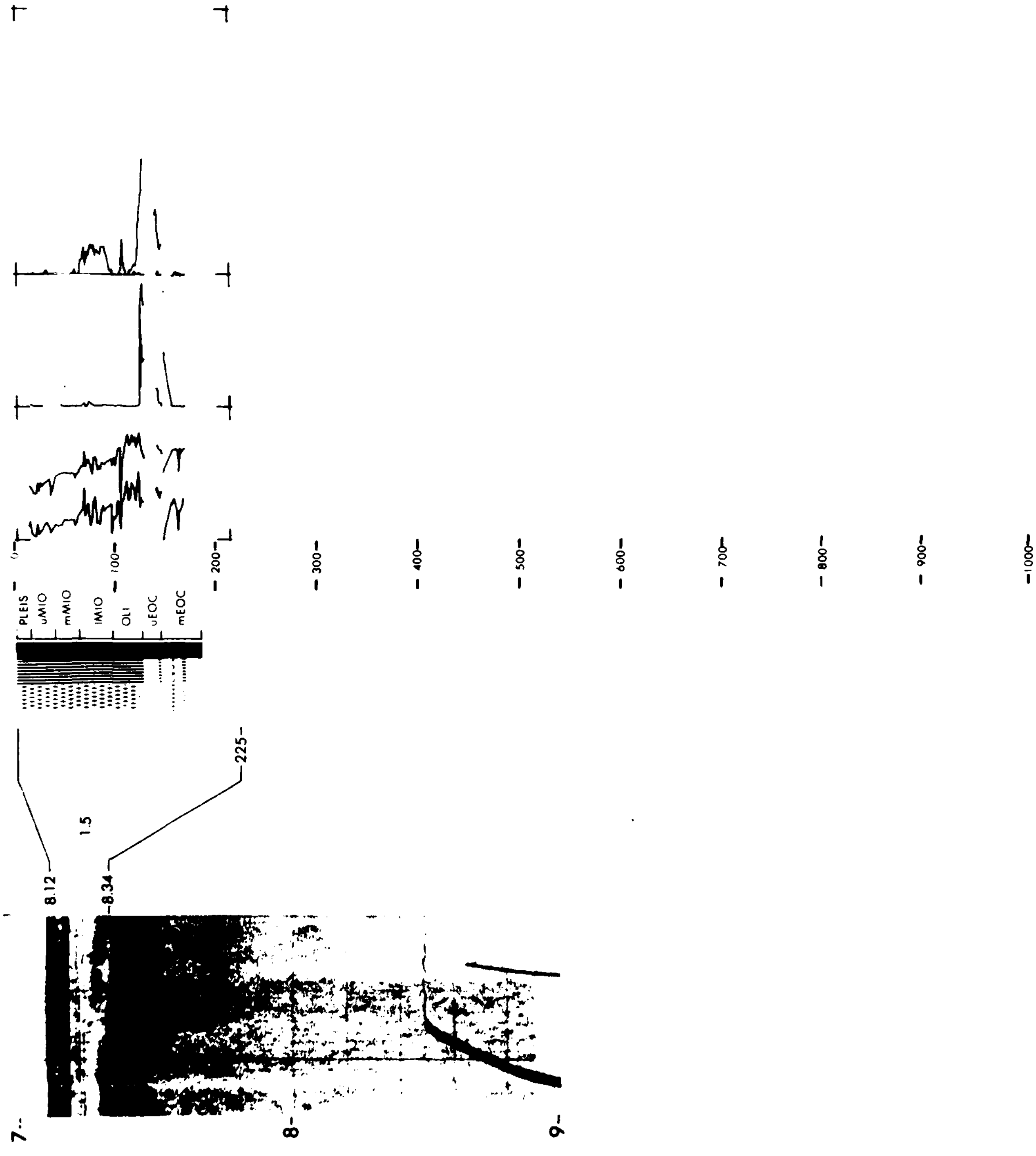
Penetration:	65	65 A	
Drilled--	0	138	meters
Cored----	145	46	meters
Total----	145	184	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	17	7	cores
	132	16	meters

A set of nearly continuous cores of an apparently uninterrupted section of radiolarian ooze ranging in age from middle Eocene to Recent was obtained, but the bit did not reach the deepest seismic reflector. Below depths of 127 meters, in the Oligocene and Eocene, thin chert and turbidite beds are sparsely interbedded with ooze. Calcareous nannofossils and detrital foraminifers, including specimens of late Cretaceous, Paleocene, and Eocene age, as well as grains of pyroclastic and hyaloclastic rocks and turbidites. The chert is commonly associated with the turbidites. Reworked radiolarians are present in a sample from the upper Eocene. Average rates of accumulation were about 4m/m.Y. The upper 127 meters is identified as part of the upper very transparent layer on reflection profiles in this region, and is at least as old as the Oligocene at its base.

Calcareous soft sediments nannofossil rich.



SITE 65 LEG 7



PLEIS
uMIO
mMIO
lMIO
OLI
uEOC
mEOC
0
100
200
300
400
500
600
700
800
900
1000
8.12
8.34
1.5
225
7
8
9

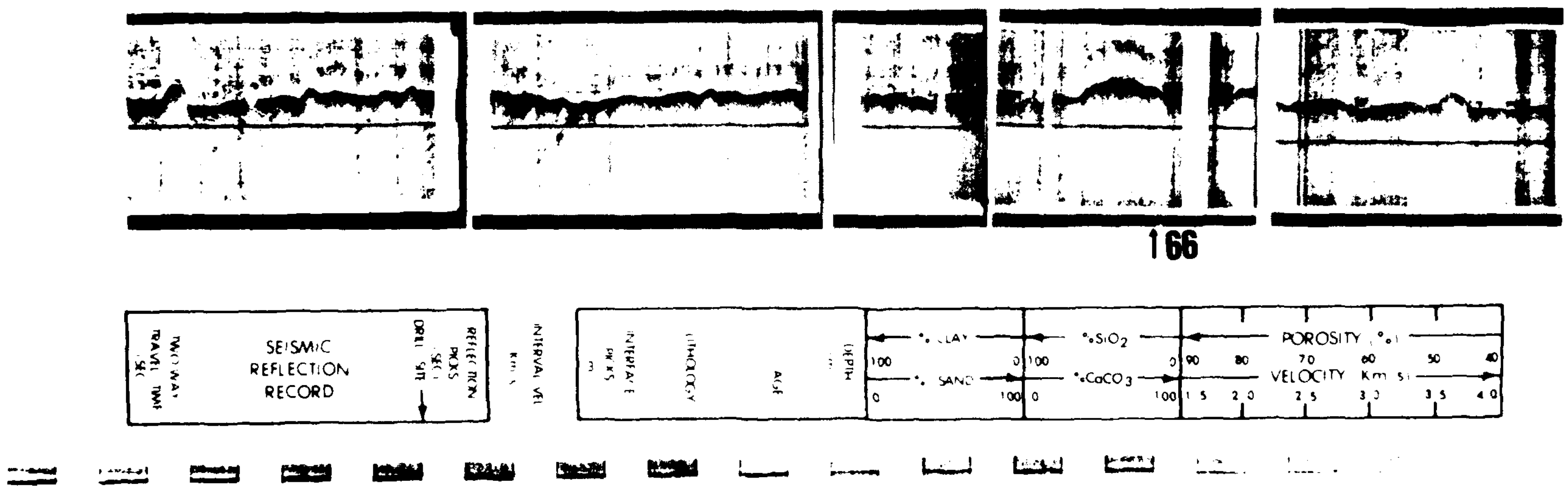
SITE DATA

Position:
Latitude 2° 23.6' N
Longitude 166° 07.3' W
Date: 09 / 19 / 69
Time: 1130Z
Water depth: 5310 meters
Location: Central Basin

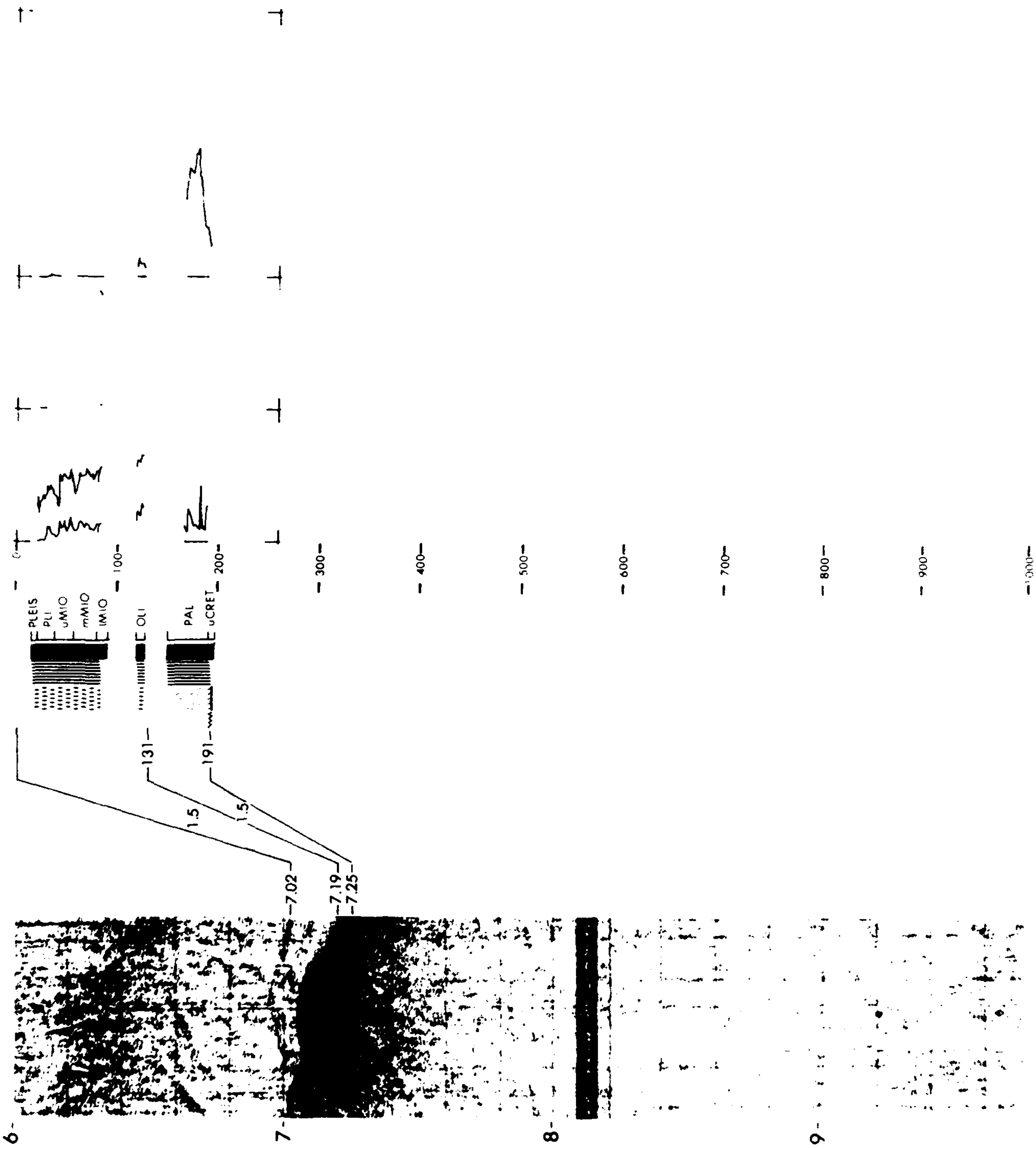
CORE DATA

Penetration:	66	66 A	
Drilled--	121	2	meters
Cored----	80	68	meters
Total----	201	70	meters
Recovery:			
Basement-	2	0	cores
	.2	0	meters
Total----	11	8	cores
	47	59	meters

An apparently uninterrupted sequence of radiolarian ooze about 163 meters thick, containing minor thin beds of chert on the lower 16 meters, overlies a section of stiff very fine-grained brown clay about 19 meters thick. Radiolarian range in age from Quaternary at the surface to Oligocene at a depth of 126 meters. Poorly preserved Cretaceous radiolarians of probable Turonian or Cenomanian age occur at 190 meters, just 2 meters above the base of the clay, interbedded with layers of volcanoclastic sand and pebbles. Living unconformably beneath the clay is altered vesicular basalt. The oozes are correlated with the seismic Transparent Layer, the interbedded cherts and oozes with the Opaque Layer, the clays with the Lower Transparent Layer, and the top of the basalt with Horizon B of Ewing et al. (1968). Rates of accumulation were about 5m/m.Y. in the ooze, and probably less than lm/m.Y. in the clay. Except for one brief time during the late Miocene, the sea floor at this site has been below the calcite compensation depth since the beginning of the sedimentary record.



SITE 66 LEG 7


PLEIS
PLI
uMIO
mMIO
lMIO
OLI
PAL
uCRET
100
200
300
400
500
600
700
800
900
1000
131
191
1.5
1.5
7.02
7.19
7.25
6
7
8
9

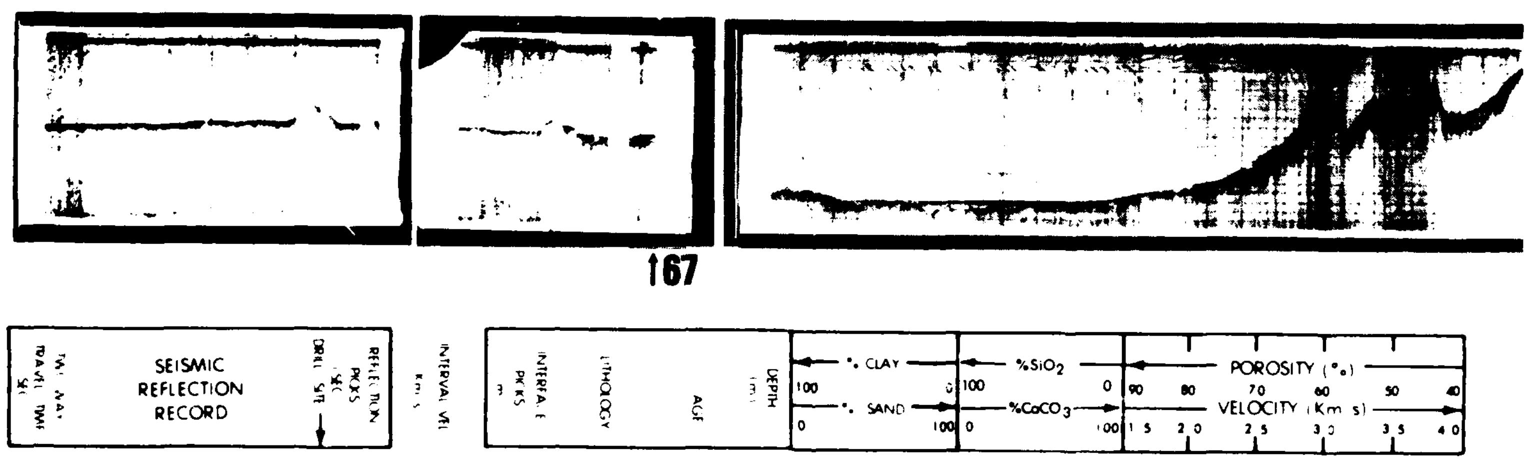
SITE DATA

Position:
Latitude 24° 22.6' N
Longitude 157° 38.9' W
Date: 09 / 28/ 69
Time: 1817 Z
Water depth: 4486 meters
Location: Hawaiian Arch

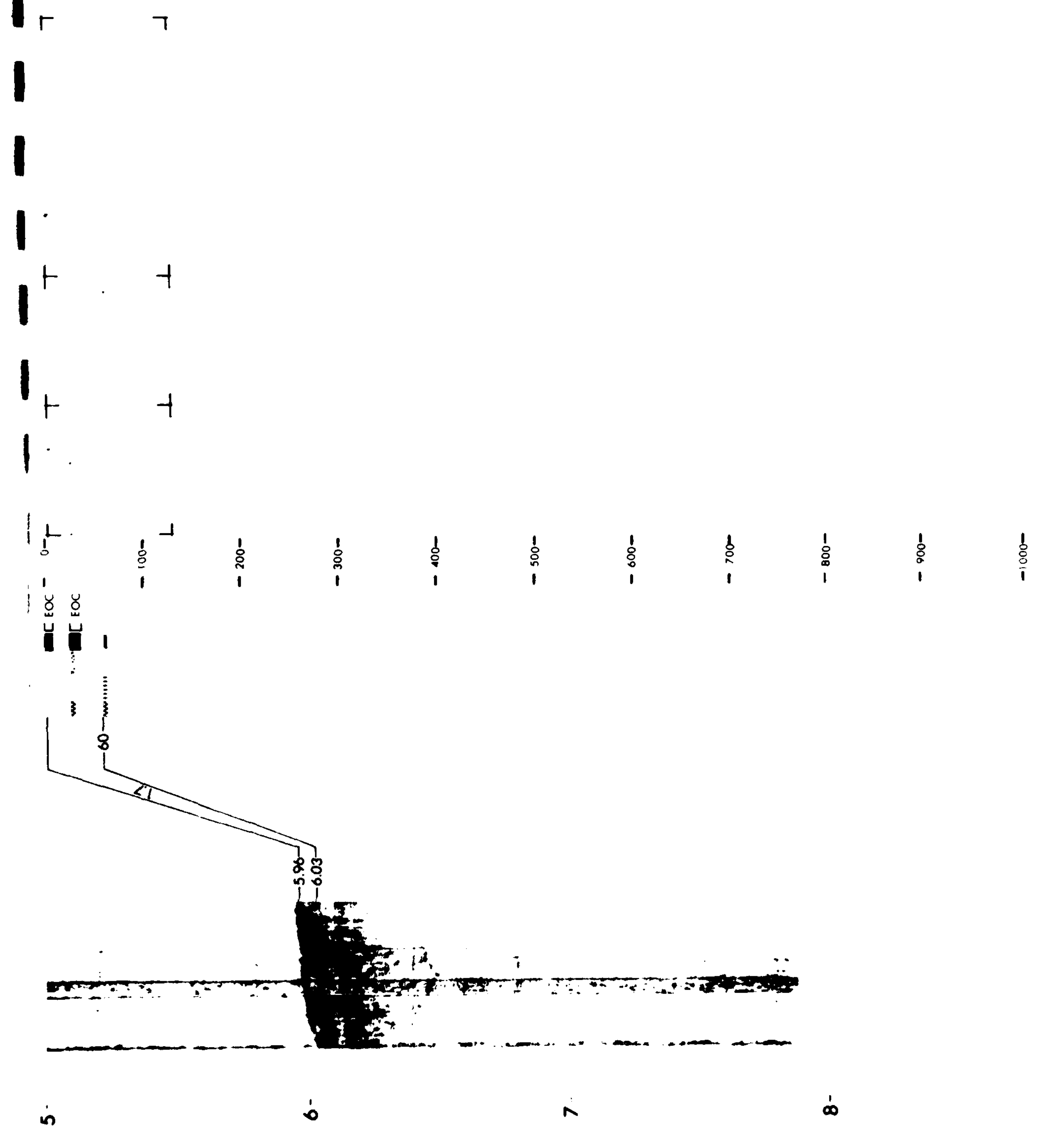
CORE DATA

Penetration:	67	67 A	
Drilled--	0	51	meters
Cored----	4	9	meters
Total----	4	60	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	2	cores
	1	2	meters

Well consolidated and bedded volcanic sandstone and mudstone, and claystone extends from the sea floor to a depth of 60 meters, where a layer of hard brown procelanite stopped the bit. Displaced radiolarians in mud from a core at 60 meters indicate sediments of early Eocene or late Paleocene age are present somewhere above that depth. Only about half of the total stratigraphic column, as inferred from seismic reflection profiles, was penetrated.



SITE 67 LEG 7



EOC
EOC
0
100
200
300
400
500
600
700
800
900
1000
60
17
5.96
6.03
5
6
7
8

SITE DATA

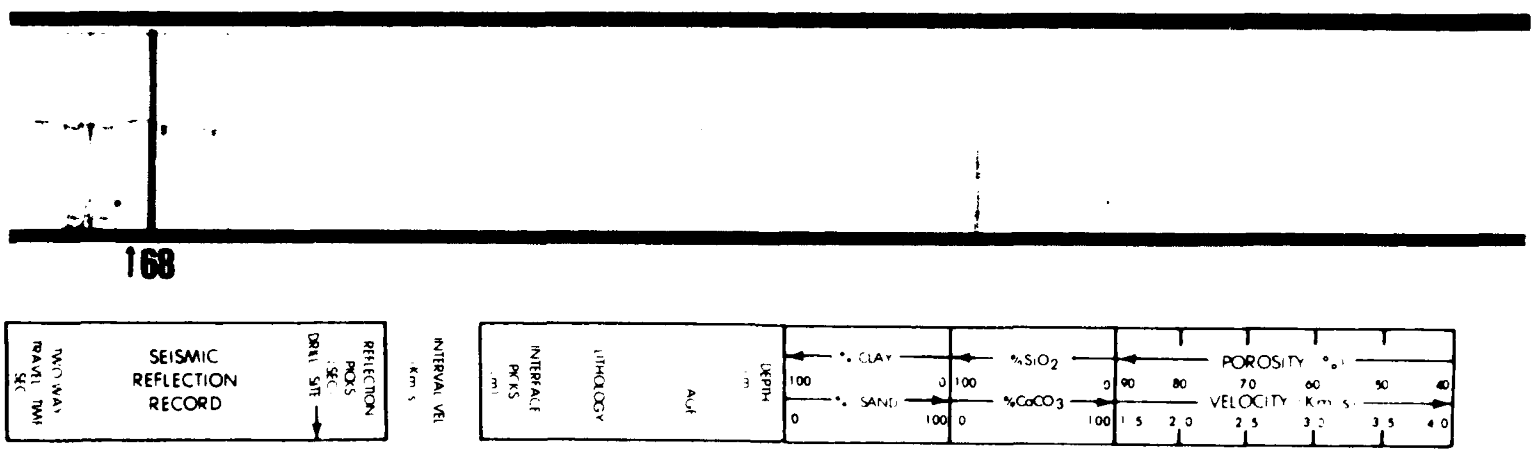
Position:
Latitude 16° 43.3' N
Longitude 164° 10.4' W
Date: 10/10/69
Time: 0730 Z
Water depth: 5466 meters
Location: Hawaiian Ridge

CORE DATA

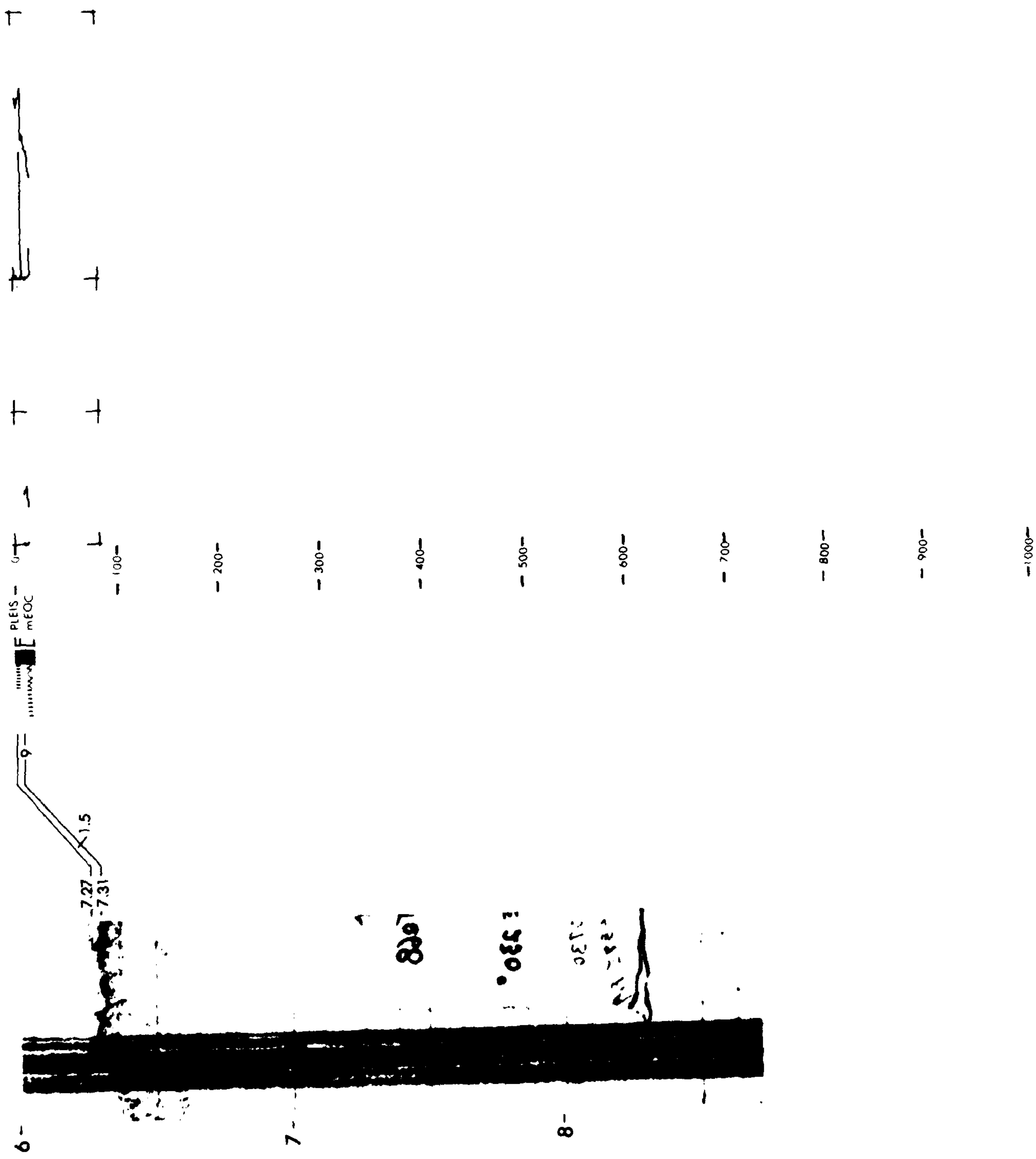
	68	68 A
Penetration:		
Drilled--	0	0 meters
Cored----	15	9 meters
Total----	15	9 meters
Recovery:		
Basement-	0	0 cores
	0	0 meters
Total----	2	1 cores
	15	0 meters

A few centimeters of pelagic ooze containing mixed Quaternary, Miocene and Eocene Radiolaria overlies middle Eocene brown clay. Thin indurated claystone and chert layers starting about 9 meters below bottom increase in number and thickness below 13 meters. The first reflecting layer was estimated to be at 35 to 50 meters.

Siliceous layer; thin and radiolaria rich.



SITE 68 LEG 8



PLEIS
mEOC
1.5
7.27
7.31
100
200
300
400
500
600
700
800
900
1000
6
7
8

SITE DATA

Position:
Latitude 6°00.0'N
Longitude 152°51.9'W
Date: 10/17/69
Time: 1245Z
Water depth: 4978 meters
Location: Northeast of Line Islands

CORE DATA

Penetration:	69	69A	
Drilled--	172	123	meters
Cored----	59	107	meters
Total----	231	230	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	8	13	cores
	37	90	meters

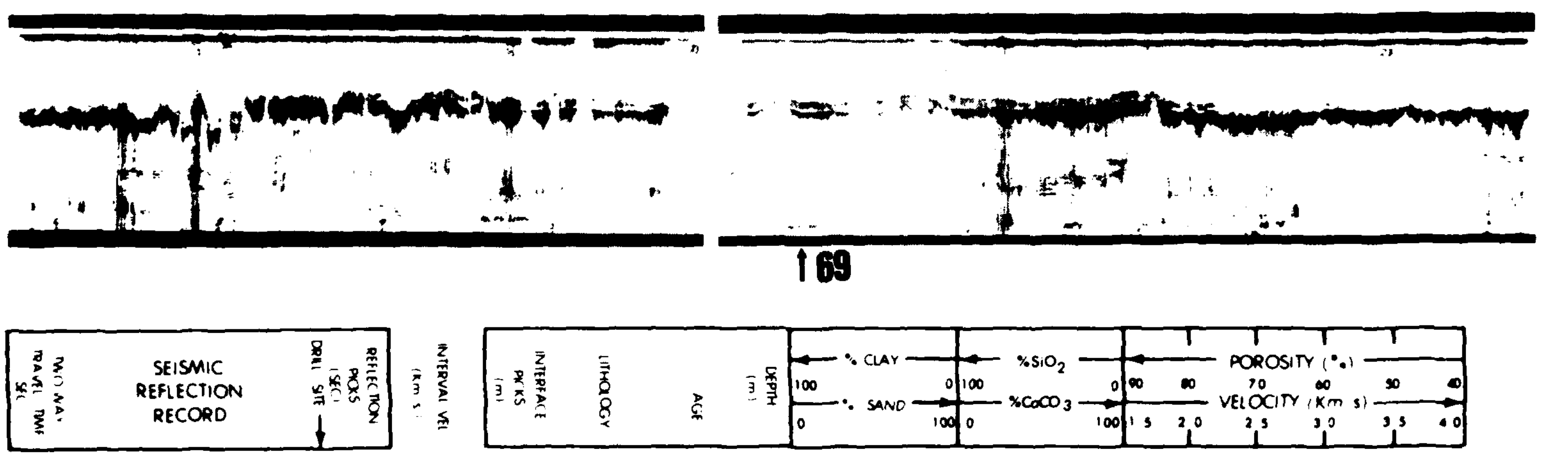
An almost complete stratigraphic section was cored from middle Miocene to middle Eocene, consisting of three lithologic units:

(1) Upper radiolarian ooze and bedded siliceous and calcareous ooze 0 to 32 meters of middle and early Miocene age; 32 to 50 meters was not cored.

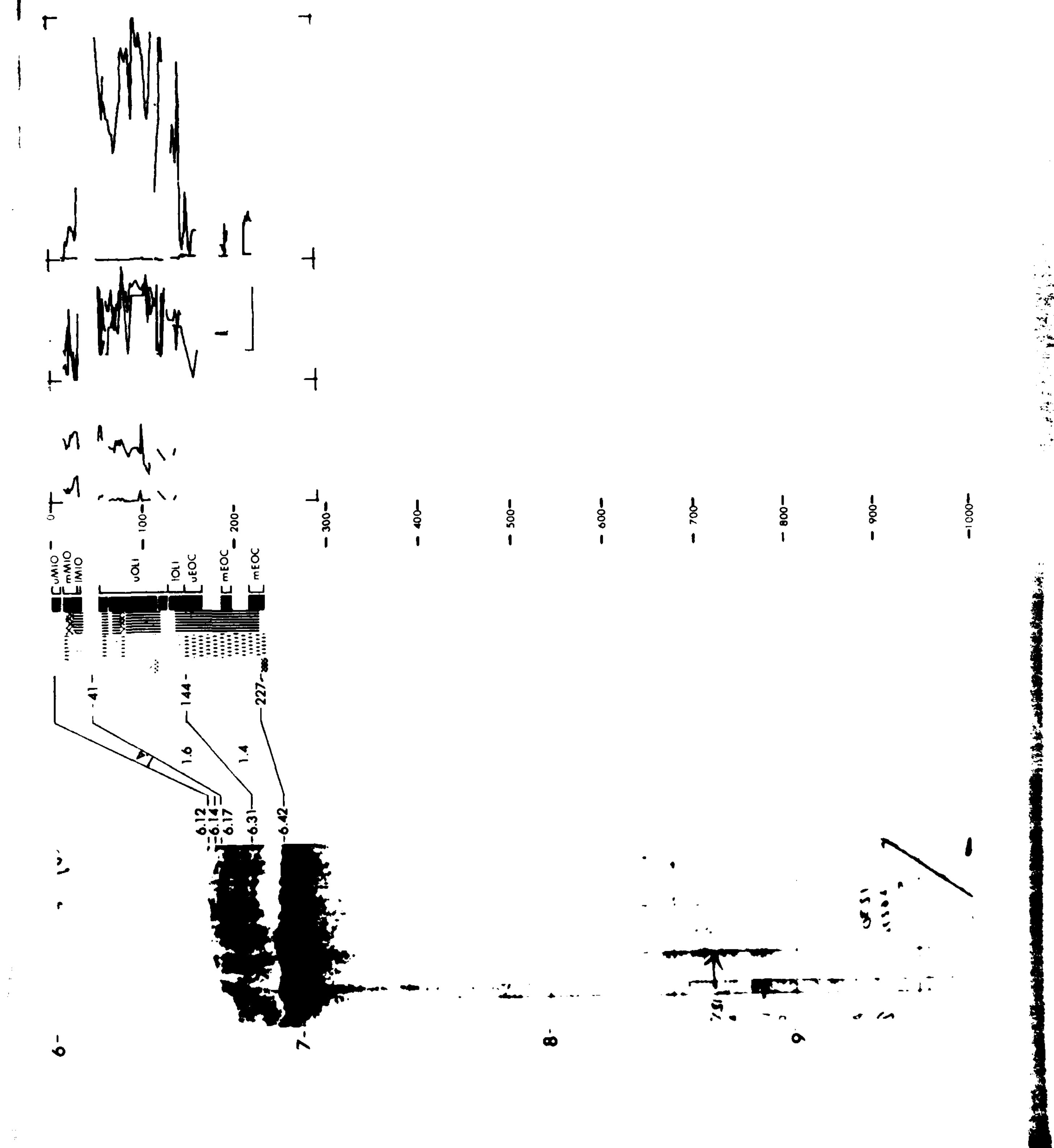
(2) Calcareous nannofossil ooze, 50 to 144 meters, of early Miocene and Oligocene age.

(3) Lower radiolarian ooze, 144 to 227 meters, of upper and middle Eocene age.

Hard chert beds below 227 meters were penetrated to 231 meters, but were not recovered. The contact between Oligocene nannofossil ooze and Eocene radiolarian ooze was very sharp. Siliceous, radiolaria rich, sediments interbedded with calcareous, nannofossil rich, sediment in thin layers.



SITE 69 LEG 8


uMIO
mMIO
lMIO
uOLI
lOLI
uEOC
mEOC
mEOC
0
100
200
300
400
500
600
700
800
900
1000
41
144
227
1.4
1.6
1.4
6.12
6.14
6.17
6.31
6.42
6
7
8
9

SITE DATA

Position:
Latitude 6°20.1' N
Longitude 140°21.7' W
Date: 11/01/69
Time: 0630Z
Water Depth: 4978 meters
Location: Clipperton Fracture Zone

CORE DATA

	70	70A	70B	
Penetration:				
Drilled--	4.7	113	56	meters
Cored----	108	218	332	meters
Total----	113	331	388	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	6	13	12	cores
	37	90	98	meters

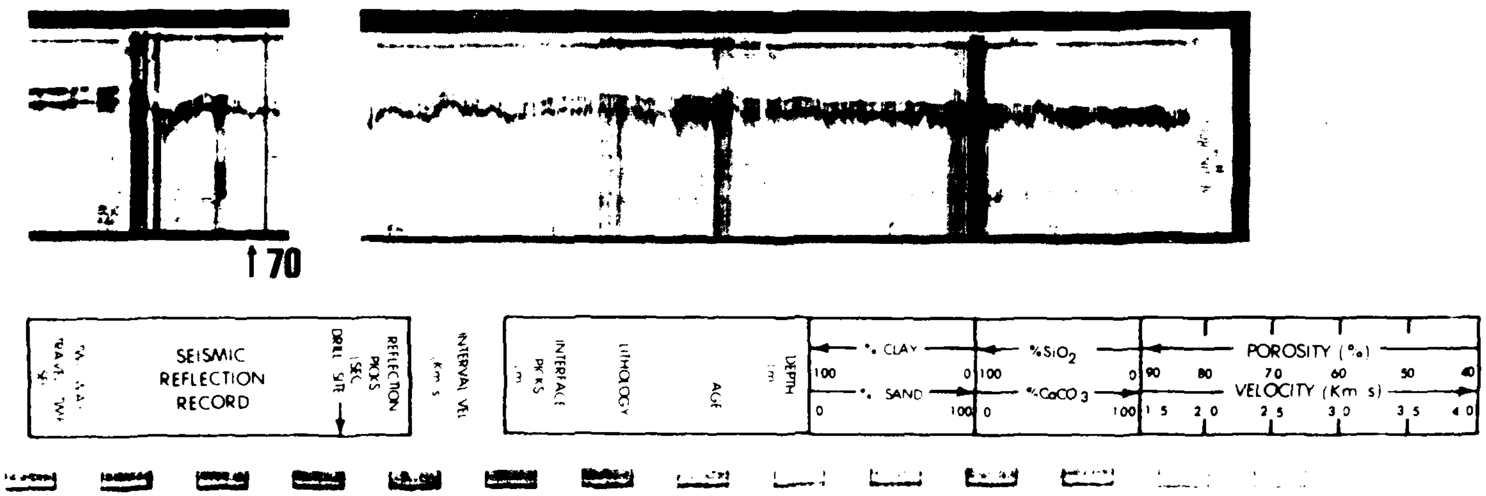
An almost complete stratigraphic section was recovered from Quaternary to middle Eocene, consisting of the following lithologic units:

(1) An upper radiolarian ooze unit (0 to 20 meters) of Quaternary, Pliocene and upper Miocene age; and a cyclic unit of radiolarian ooze and radiolarian-nannofossil ooze (20 to 45 meters) of middle and lower Miocene age.

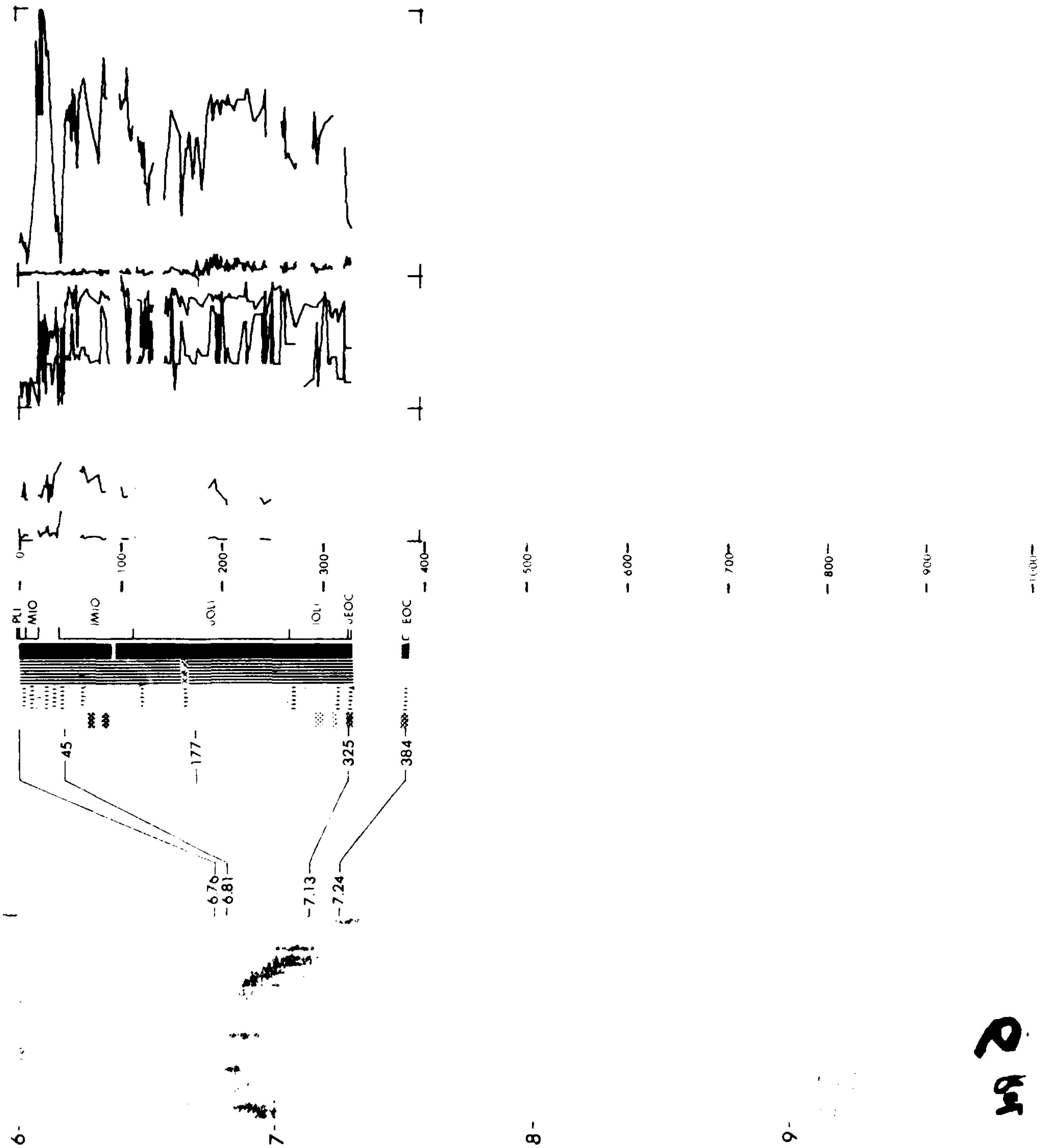
(2) A highly calcareous unit of radiolarian-nannofossil and nannofossil ooze (45 to 324 meters) that becomes a chalk below 177 meters, of lower Miocene and Oligocene age.

(3) A lower radiolarian ooze unit, semi-indurated, 324 to 328 meters, of upper Eocene age overlying chert (328 to 388 meters) of upper Eocene age overlying chert (328 to 388 meters) of middle Eocene age. The interval 331 to 384 meters was not cored, and probably consists mostly of brown radiolarian ooze. Two zones of hiatus were recognized in the Pliocene and one in the upper part on the upper Eocene.

Interbedded calcareous, nannofossil rich, and siliceous, radiolaria rich, sediments.



SITE 70 LEG 8



0
100
200
300
400
500
600
700
800
900
1000
45
177
325
384
6.76
6.81
7.13
7.24
6
7
8
9

SITE DATA

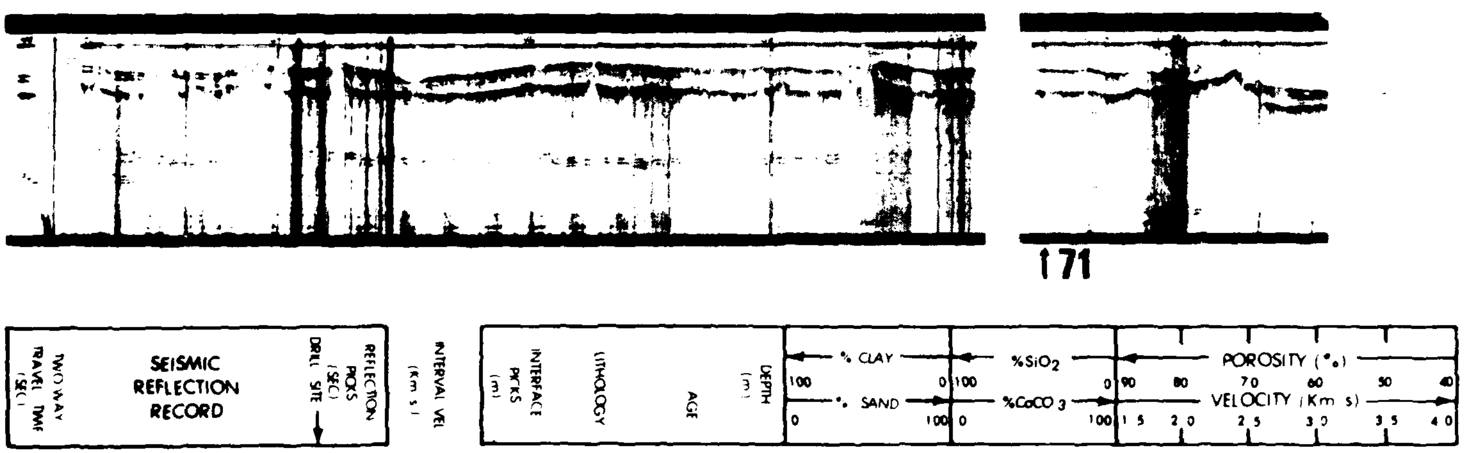
Position:
Latitude $4^{\circ}28.3'$ N
Longitude $140^{\circ}18.9'$ W
Date: 11/01/69
Time: 2118Z
Water depth: 4419 meters
Location: South of Clipperton Fracture Zone

CORE DATA

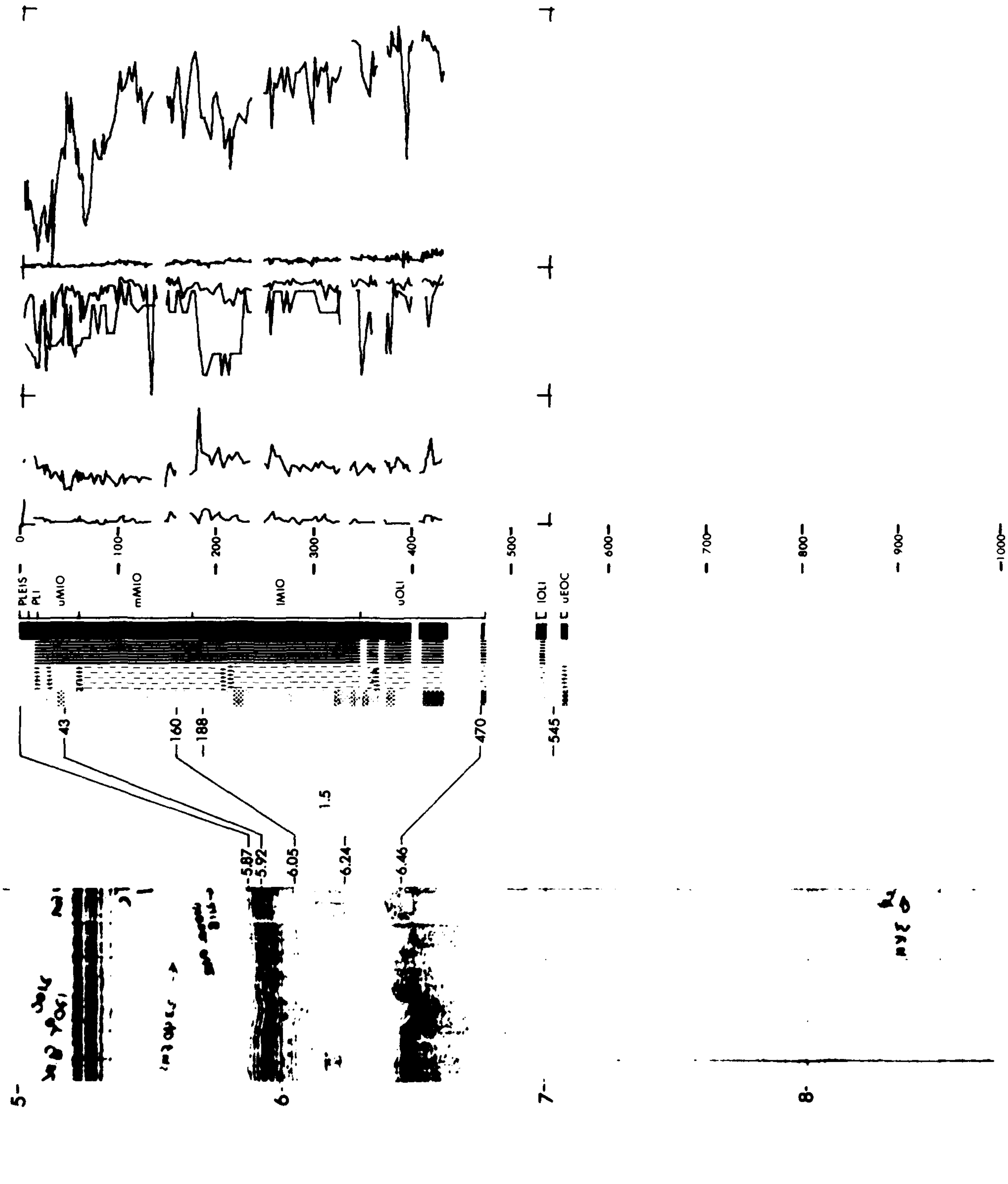
Penetration:	71	71A	
Drilled--	39	544	meters
Cored----	436	14	meters
Total----	475	558	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	49	3	cores
	367	6	meters

Continuous core from the surface to 436 meters provides an excellent record of the stratigraphic succession from Quaternary into upper Oligocene sediments. In redrill Hole 71 A, using a heavier bit, lower cores were taken in lower Oligocene chalky limestones; and probable upper Eocene siliceous limestone and calcareous chert.

Calcareous, nannofossil rich, sediments, interbedded with thin layers of siliceous, occasionally radiolaria rich, sediment.



SITE 71 LEG 8



0
100
200
300
400
500
600
700
800
900
1000
PLEIS
PLI
uMIO
mMIO
lMIO
uOLI
lOLI
uEOC
43
160
188
470
545
1.5
5.87
5.92
6.05
6.24
6.46
5
6
7
8

SITE DATA

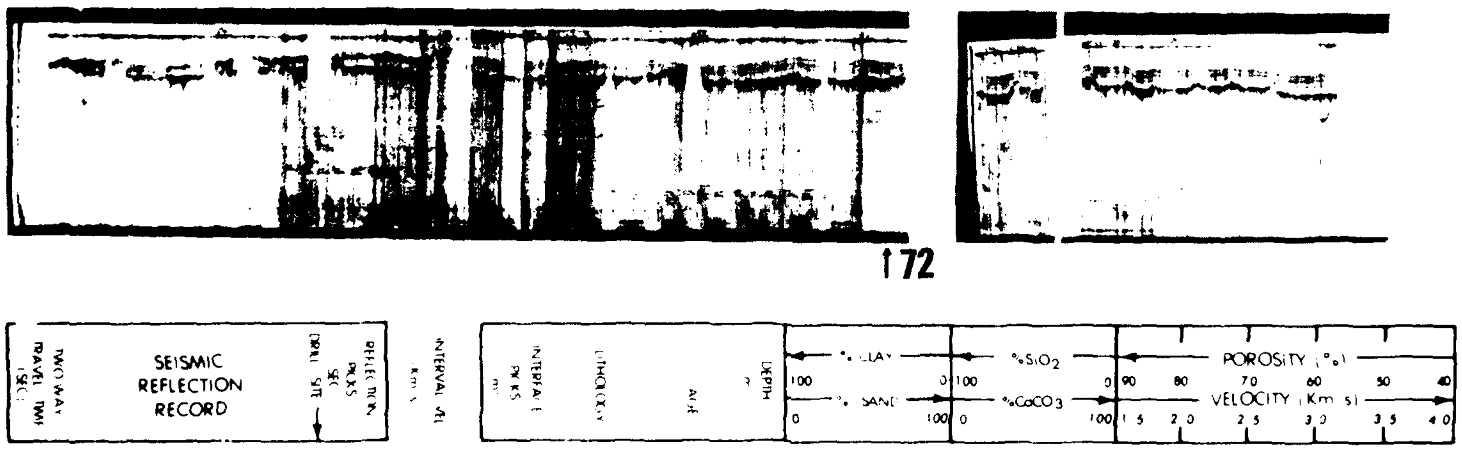
Position:
Latitude $0^{\circ}26.5'$ N
Longitude $138^{\circ}52.0'$ W
Date: 11/15/69
Time: 1130Z
Water depth: 4419 meters
Location: Northeast of Marquesas Islands

CORE DATA

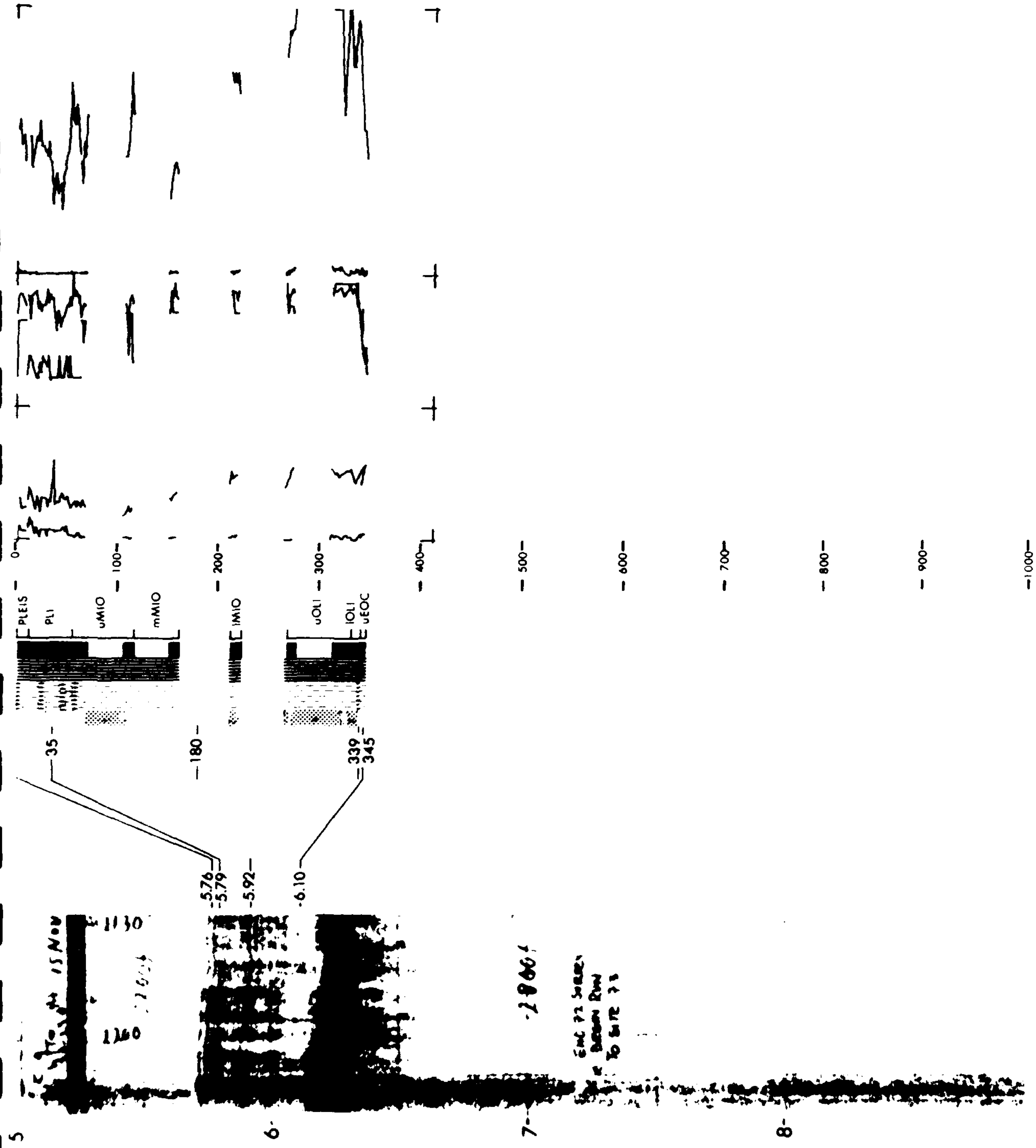
Penetration:	72	72A	
Drilled--	257	8.1	meters
Cored----	88	55	meters
Total----	345	63	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	86	6	cores
	98	48	meters

Intermittent coring resulted in the recovery of a complete section from Quaternary at the sea floor down into the upper Miocene, an incomplete section through the Miocene and the Oligocene, and a continuous section of the lower portion of the hole ranging from Oligocene onto the upper Eocene. The hole was drilled on a flank of a buried hill over which the sediments are compressed particularly towards the base of the column (as shown by reflection profiles). Thicknesses and sediment accumulation rates on Oligocene sediments are probably not representative for the area.

Interbedded siliceous, radiolaria rich, and calcareous, nannofossil rich, sediments.



SITE 72 LEG 8



PLEIS
PLI
uMIO
mMIO
lMIO
uOLI
lOLI
uEOC
0
100
200
300
400
500
600
700
800
900
1000
35
180
339
345
5.76
5.79
5.92
6.10
5
6
7
8

SITE DATA

Position:
Latitude $1^{\circ}54.6'$ S
Longitude $137^{\circ}28.1'$ W
Date: 11/19/69
Time: 1900Z
Water depth: 4387 meters
Location: Northeast of Marquesas Islands

CORE DATA

Penetration:
Drilled-- 129 meters
Cored---- 173 meters
Total---- 302 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 21 cores
170 meters

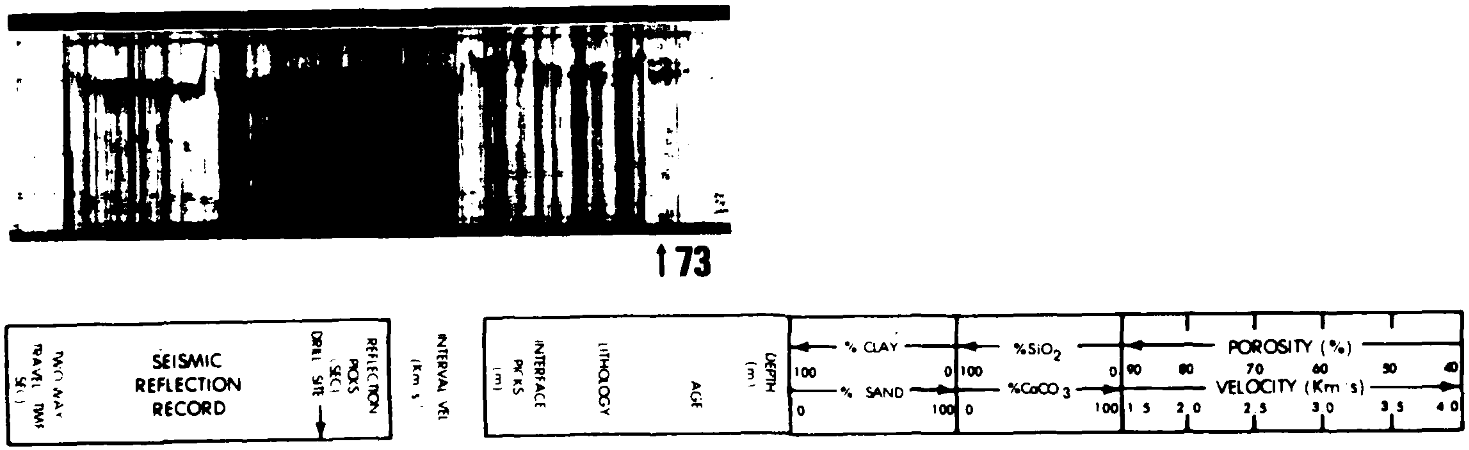
The cored sediments may be grouped into three principle sequences:

(1) An upper layered sequence, 74 meters thick, of Quaternary to Middle Miocene age comprising repetitive beds of variable carbonate content (radiolarian-nannofossil and nannofossil-radiolarian ooze) (0 to 65 meters) of Quaternary, Pliocene and Upper Miocene age, overlying a bedded siliceous ooze, dominantly radiolarian (67 to 74 meters) of upper and middle Miocene age, but containing a dominant assemblage of reworked lower Miocene species.

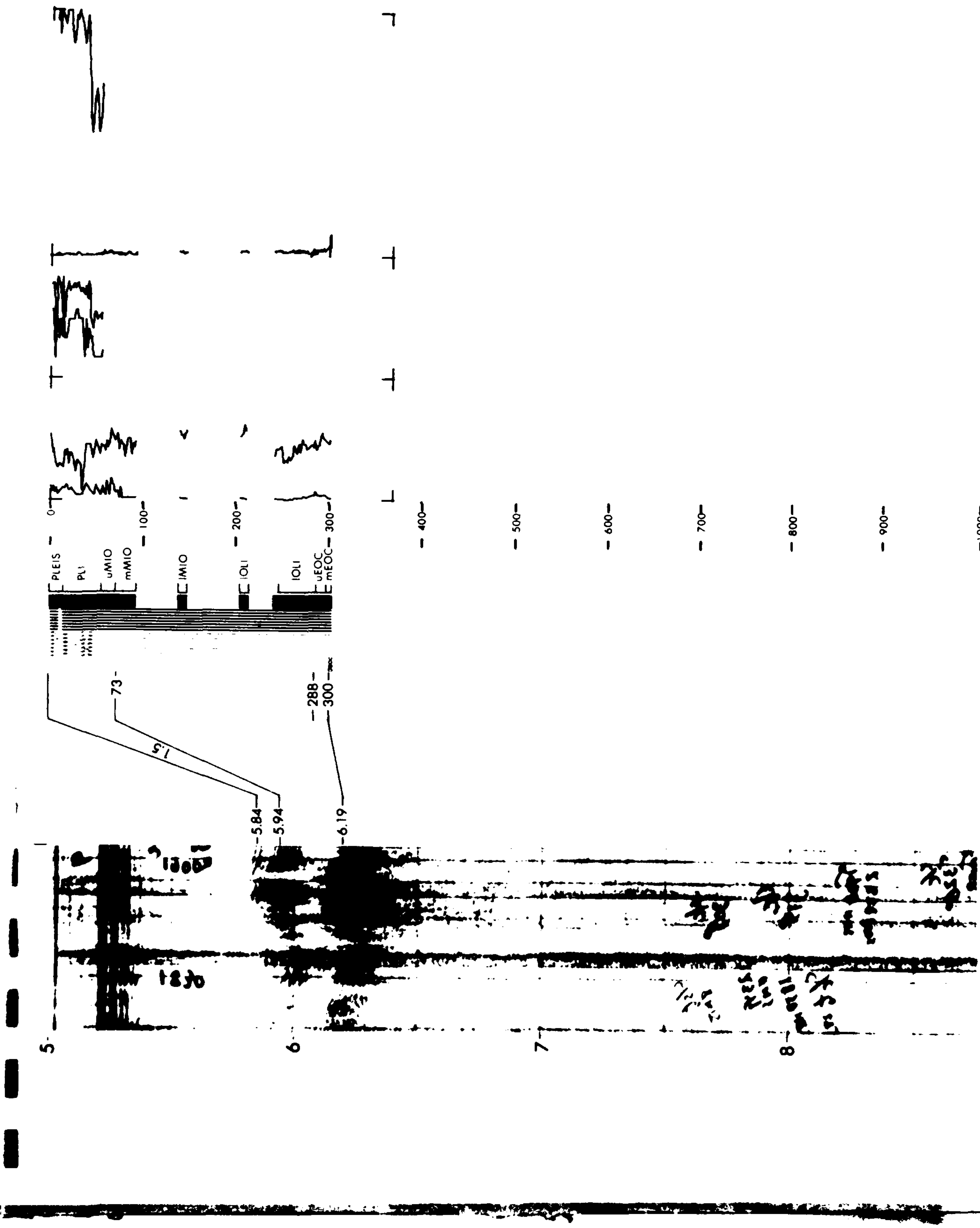
(2) A high-carbonate sequence (radiolarian-nannofossil to nannofossil ooze, 65 to 288 meters) of middle Miocene to lower Oligocene age.

(3) Bedded carbonate ooze, siliceous chalk and chert (288 to 302 meters) of upper and middle Eocene age.

Overall sediments interbedded calcareous and siliceous oozes. Some calcareous, nannofossil rich.



SITE 73 LEG 8



PLEIS
PL1
uMIO
mMIO
lMIO
lOLI
lOLI
uEOC
mEOC
0
100
200
300
400
500
600
700
800
900
1000
73
288
300
1.5
5.84
5.94
6.19
5
6
7
8

SITE DATA	
Position:	
Latitude	6°14.2' S
Longitude	136°05.8' W
Date:	11/22/69
Time:	2245Z
Water depth:	4431 meters
Location:	Northeast of Marquesas Islands

CORE DATA		
Penetration:		
Drilled--	0	meters
Cored----	102	meters
Total----	102	meters
Recovery:		
Basement-	1	cores
	.03	meters
Total----	12	cores
	74	meters

A continuous section was cored that included:

(1) A bedded sequence primarily of high silica radiolarian ooze (0 to 24 meters) of Quaternary to early Miocene age.

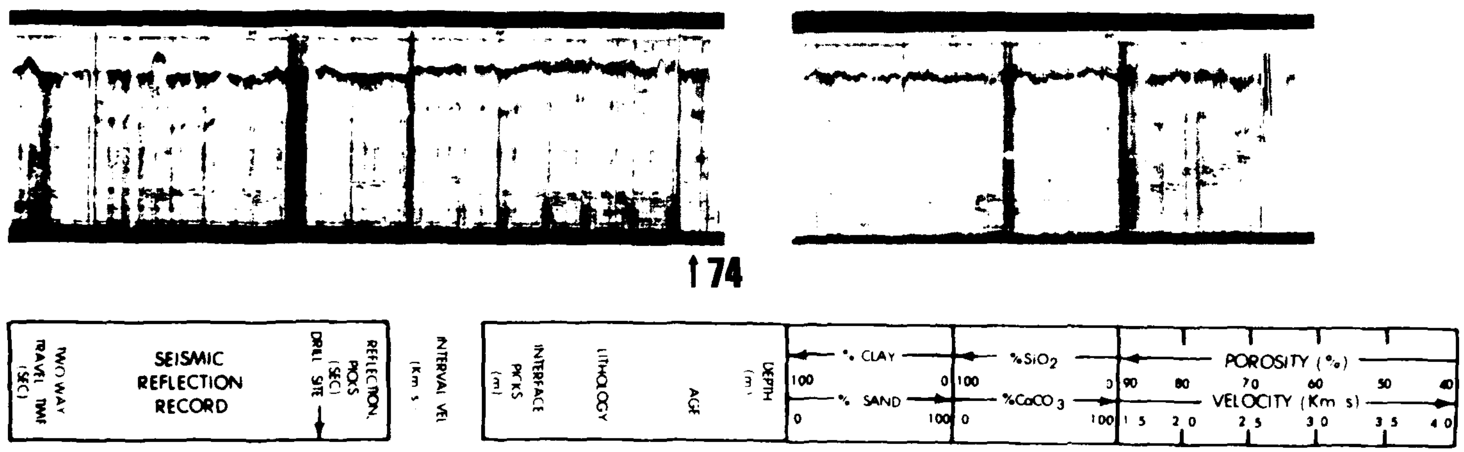
(2) A uniform sequence of high carbonate ooze, chiefly composed of calcareous nannofossils (30 to 100 meters) of early Miocene and Oligocene age.

(3) A calcareous (nannofossil) ooze containing phillipsitic clay and at the base, volcanic shards and mineral grains, 100 to 102 meters, of late and middle Eocene age.

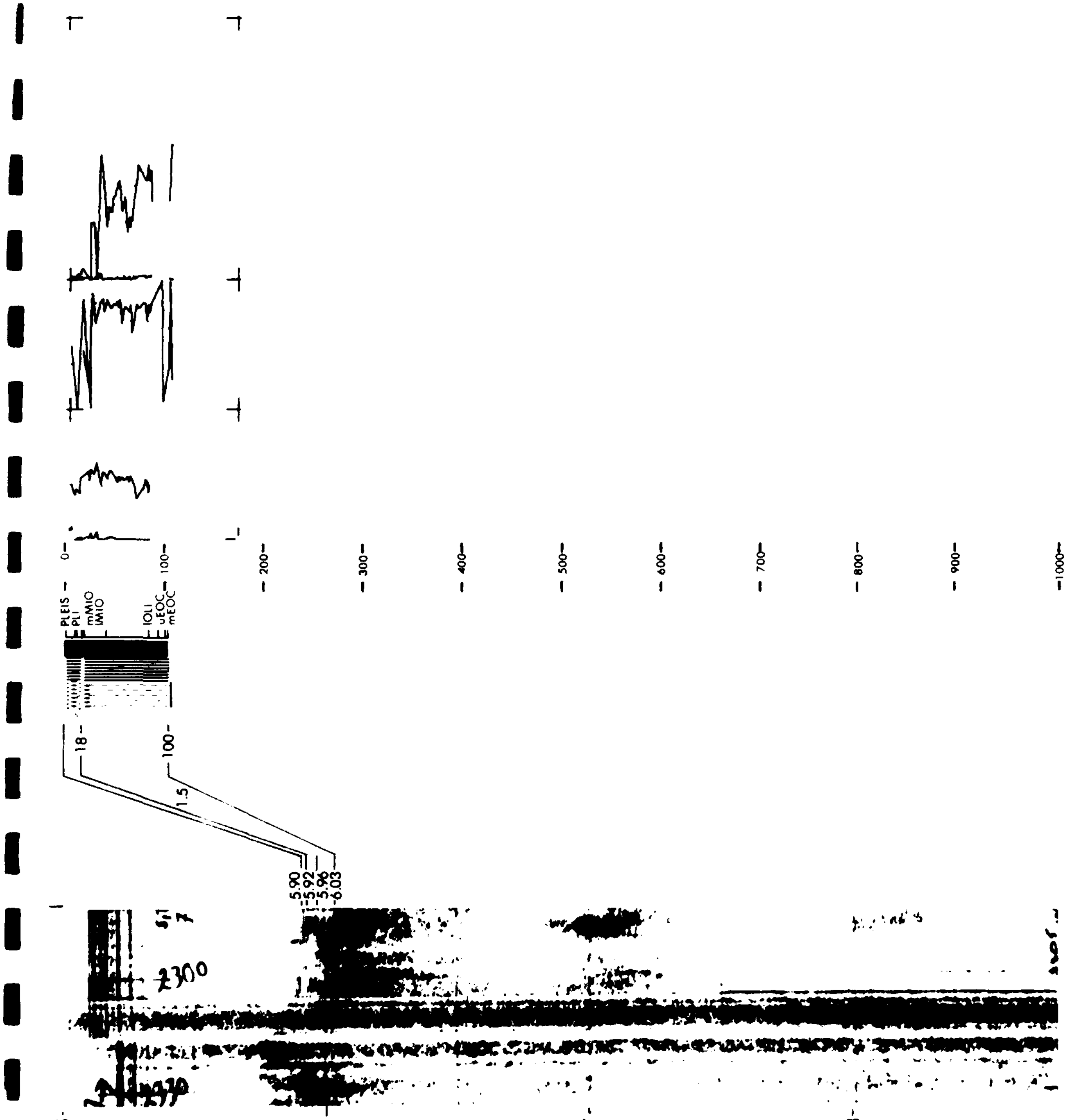
(4) Crystalline igneous rock, probably basalt, somewhat weathered, and a fragment of indurated carbonate tuff.

Overall sediments interbedded siliceous and calcareous oozes.

Siliceous sediment; radiolaria rich. Calcareous sediment; rarely nannofossil rich.



SITE 74 LEG 8


PLEIS
PLI
mMIO
lMIO
lOLI
uEOC
mEOC
18
100
1.5
5.90
5.92
5.96
6.03
2300
0
100
200
300
400
500
600
700
800
900
1000
5
6
7
8

SITE DATA

Position:
Latitude 12°31.0' S
Longitude 134°16.0'
Date: 11/27/69
Time: 1500Z
Water depth: 4181 meters
Location: Southeast of Marquesas Islands

CORE DATA

Penetration:	75	75A	
Drilled--	0	82	meters
Cored----	82	0	meters
Total----	82	82	meters
Recovery:			
Basement-	0	1	cores
	0	.03	meters
Total----	10	1	cores
	89	0	meters

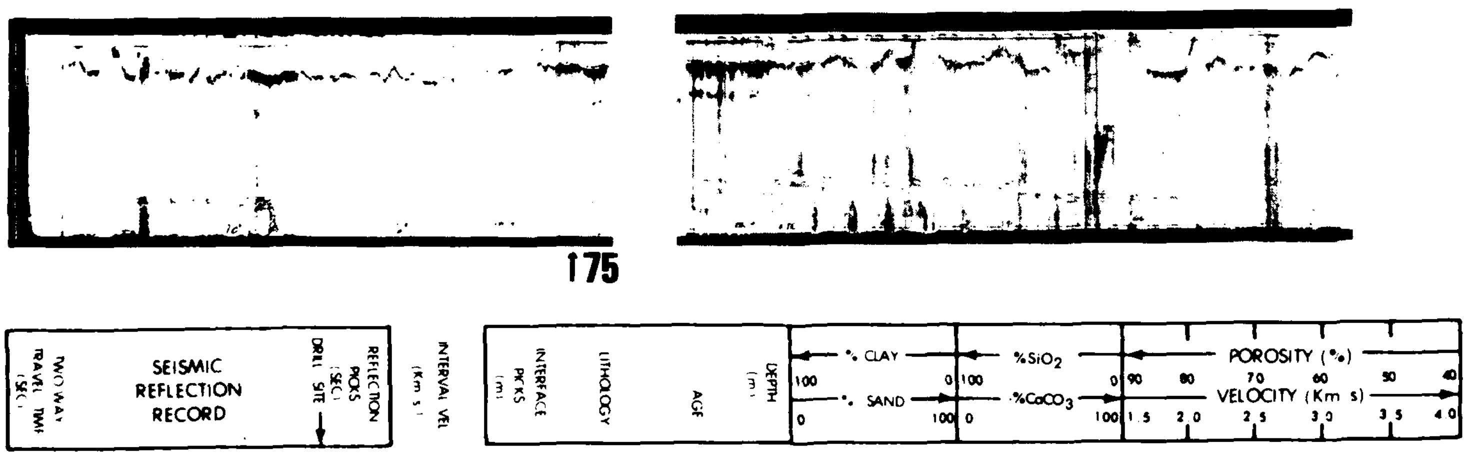
The cored sediments comprise three lithologic units:

(1) An upper unit of red clay (0 to 1.3 meters) containing Quaternary foraminifera of the top and in several thin layers.

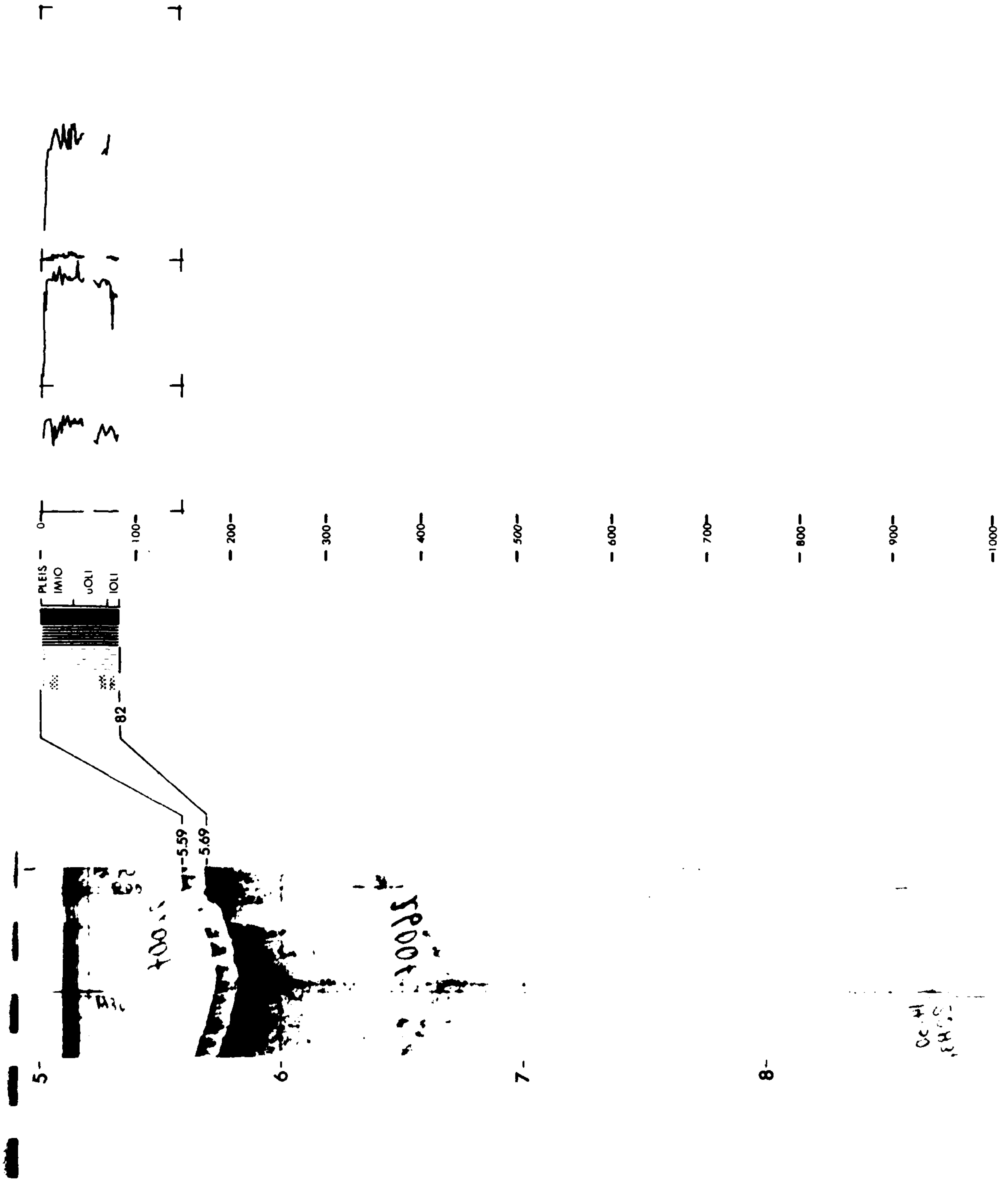
(2) A moderately uniform lower Miocene and Oligocene sequence of high carbonate content composed of very pure calcareous nannofossil ooze, with minor amounts of red clay (2 to 82 meters). The basal 8 meters, lower Oligocene in age, is approximately one-half red clay calcareous nannofossils; the rest finely divided iron-manganese.

(3) Basalt, partly glassy, with palagonite, partly finely crystalline.

Overall sediments calcareous, nannofossil rich.



SITE 75 LEG 8



PLEIS
lMIO
uOLI
lOLI
0
100
200
300
400
500
600
700
800
900
1000
82
5.59
5.69
5
6
7
8

SITE DATA

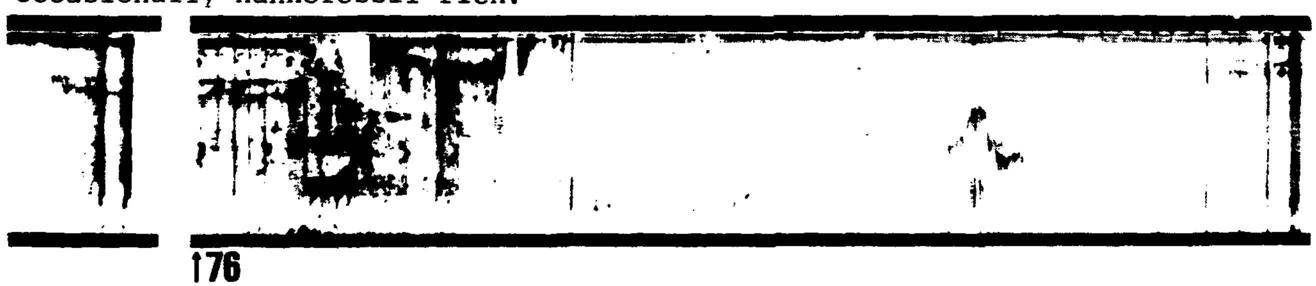
Position:
Latitude 14° 05.9' S
Longitude 145° 39.6' W
Date: 12/08/69
Time: 0130Z
Water depth: 4598 meters
Location: Tuamotu Archipelago

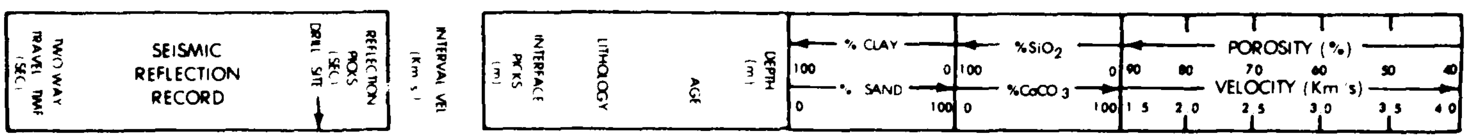
CORE DATA

Penetration:	76	76 A	
Drilled--	18	9.1	meters
Cored----	9.1	18	meters
Total----	27	27	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	2	cores
	9.1	17	meters

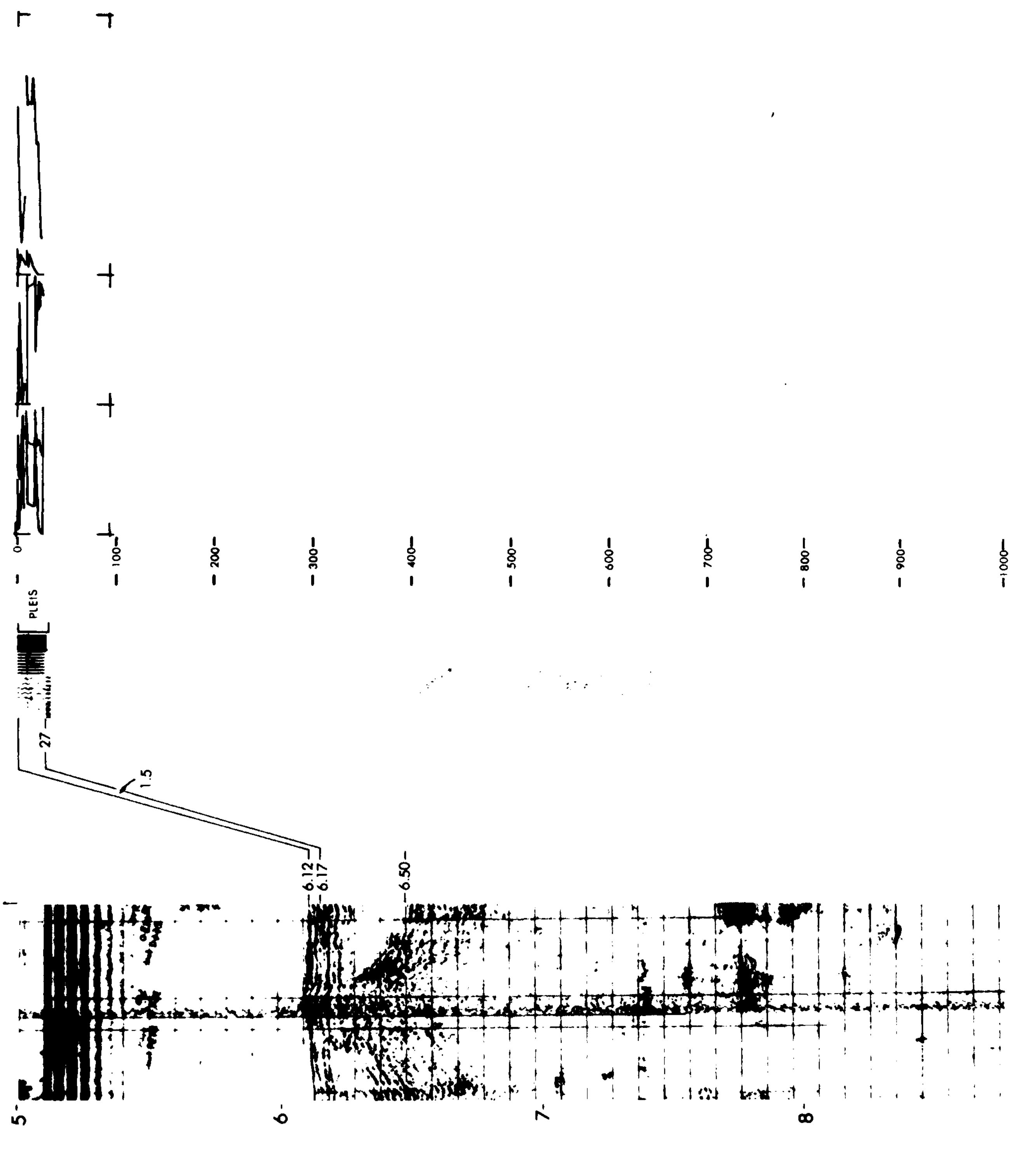
The chert layer which stopped our drilling probably occupies the top of a thick series of interbedded cherts. All three cores form this site contained coarse-grained sand beds, many with sharp upper and lower contacts, alternating with either dark chocolate brown phillopsitic clay or brown clay intermixed with nannofossil ooze. The fine and coarse-grained calcareous debris has been swept to this location from the nearby Tuamotu Islands by turbidity and bottom currents. This model is not difficult to defend, because the coarse-grained layers contain genera of shallow water benthonic foraminifera. If the Tuamotu atolls were built on the top of extinct volcanoes, then the volcanoes must have been in existence during early Eocene time. The small piece of chert that was present in the core catcher of Core 2, Hole 76A, appears to be coarse grain - supported silicified sediment. It immediately underlies a turbidite, and we conclude that the chert is the lower silicified portion of the turbidite. Chert was not observed in the pelagic sediment between the turbidites, and we conclude from this that the turbidite is important in the formation of chert.

Pliocene sediments calcareous with a few thin beds detrital. Calcareous sediments occasionally nannofossil rich.





SITE 76 LEG 9


PLEIS
27
1.5
6.12
6.17
6.50
0
100
200
300
400
500
600
700
800
900
1000
5
6
7
8

SITE DATA

Position:
- Latitude 0°28.9'N
- Longitude 133°13.7'W

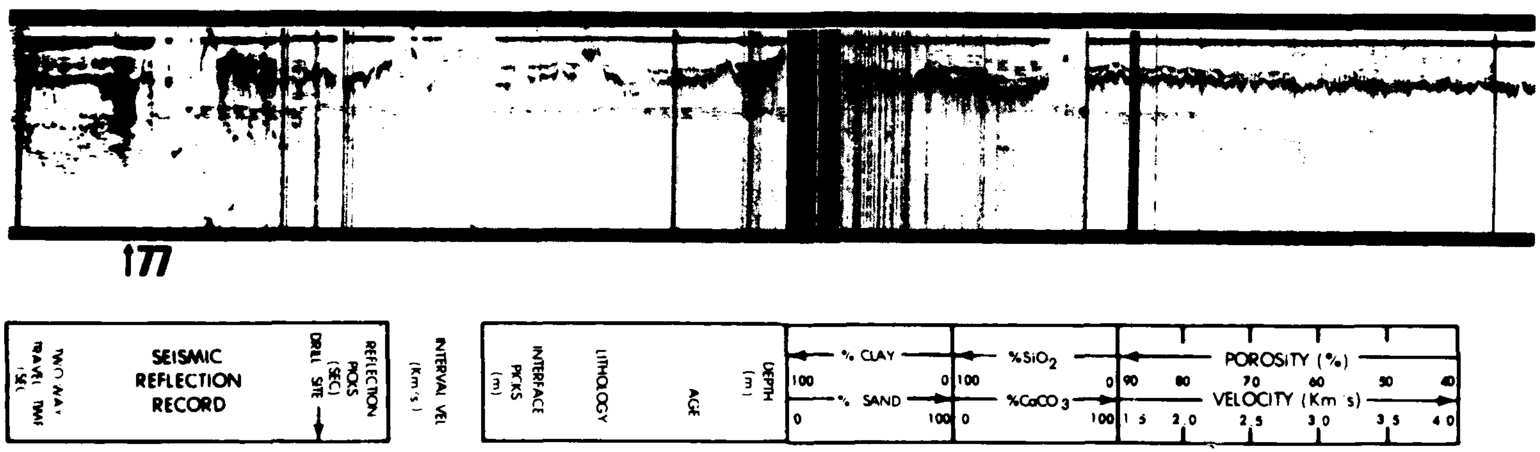
Date: 12/15/69
Time: 1400 Z
Water depth: 4291 meters
Location: Equatorial Pacific sediment belt

CORE DATA

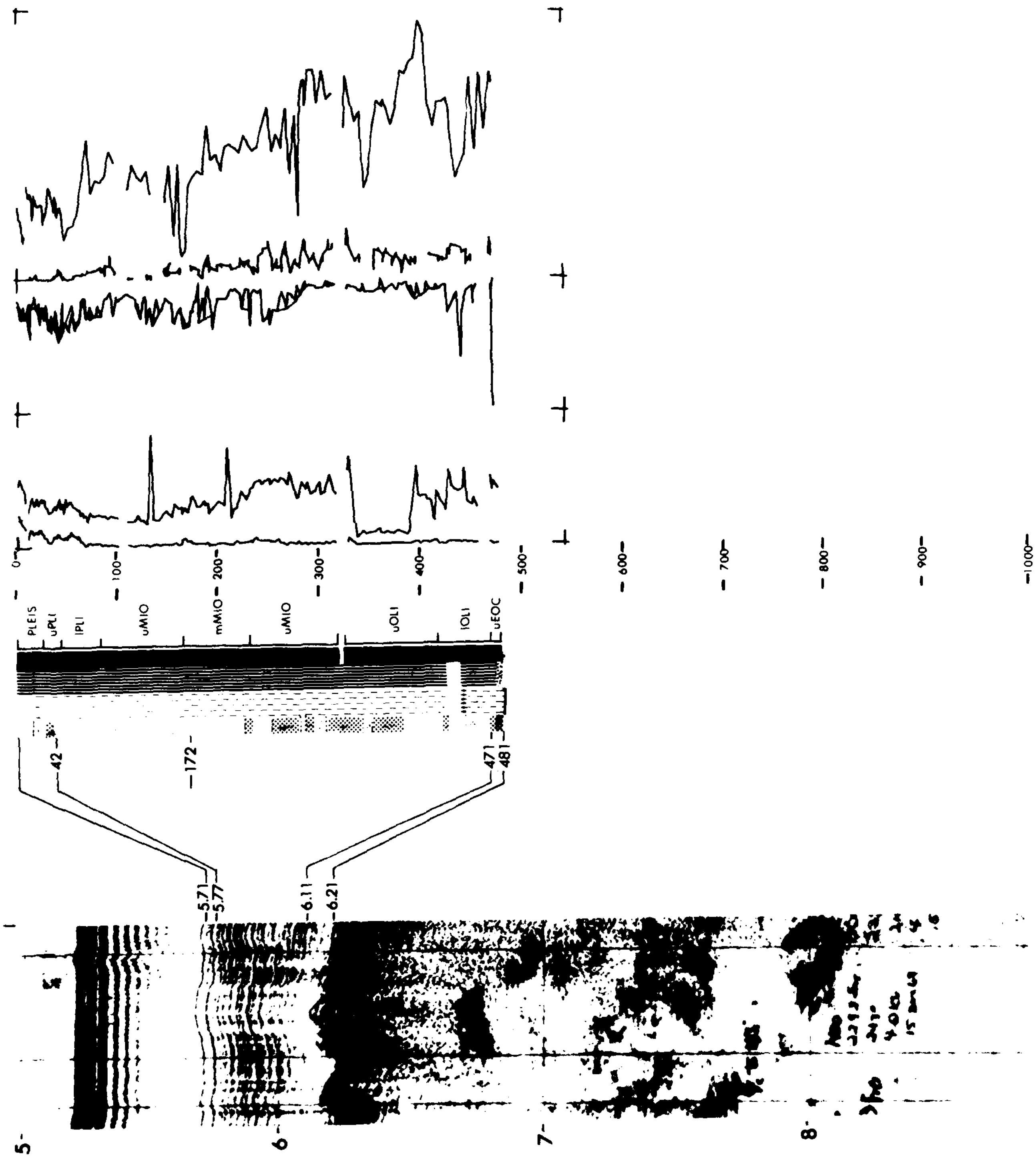
Penetration:	77	77 A	77 B	77 C	
Drilled--	0	0	9.2	92	meters
Cored----	9	18	472	9.1	meters
Total----	9	18	481	101	meters
Recovery:					
Basement-	0	0	1	0	cores
	0	0	.3	0	meters
Total----	1	2	54	1	cores
	.3	9.1	438	7.6	meters

The lithology can be divided into three formations. First, interbedded, siliceous calcareous ooze which is the cyclic unit of the Clipperton Oceanic Formation. Second, the sediments are interbedded white and purple, calcareous-siliceous ooze and chalk forming the varicolored unit of the Clipperton Oceanic Formation, and third, the sediments are the interbedded, white and orange, calcareous and siliceous chalk and ooze of the Marquesas Oceanic Formation. The basal 10.2 meters of highly ferro-manganese clay is defined as the Line Islands Oceanic Formation. The fossil faunas show very little or no mixing while the coccoliths show considerably more. In the upper Pliocene, in particular, there is considerable reworking of Miocene coccoliths. The 18 meters of ferro-manganese clay at the base of the section overlying basalt is in striking contrast with the overlying chalk lithology. The contact between the two is gradational through about 60 centimeters. The origin of the clay is problematical. One possible explanation is that these clays are a result of alteration of the organic oozes in this area by hydrothermal solutions rich in iron and manganese.

Overall sediments calcareous,(nannofossil rich. One thin bed of)siliceous ooze, diatom rich, of lower Oligocene age.



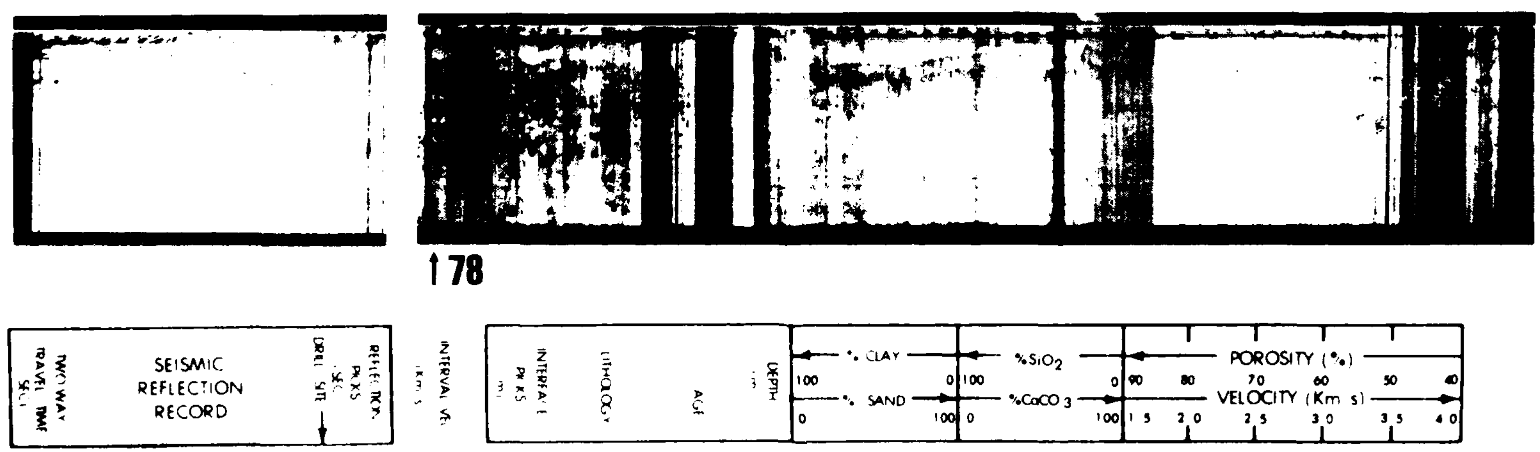
SITE 77 LEG 9


0
100
200
300
400
500
600
700
800
900
1000
PLEIS
uPLI
lPLI
uMIO
mMIO
lMIO
uOLI
lOLI
uEOC
42
172
471
481
5.71
5.77
6.11
6.21
5
6
7
8

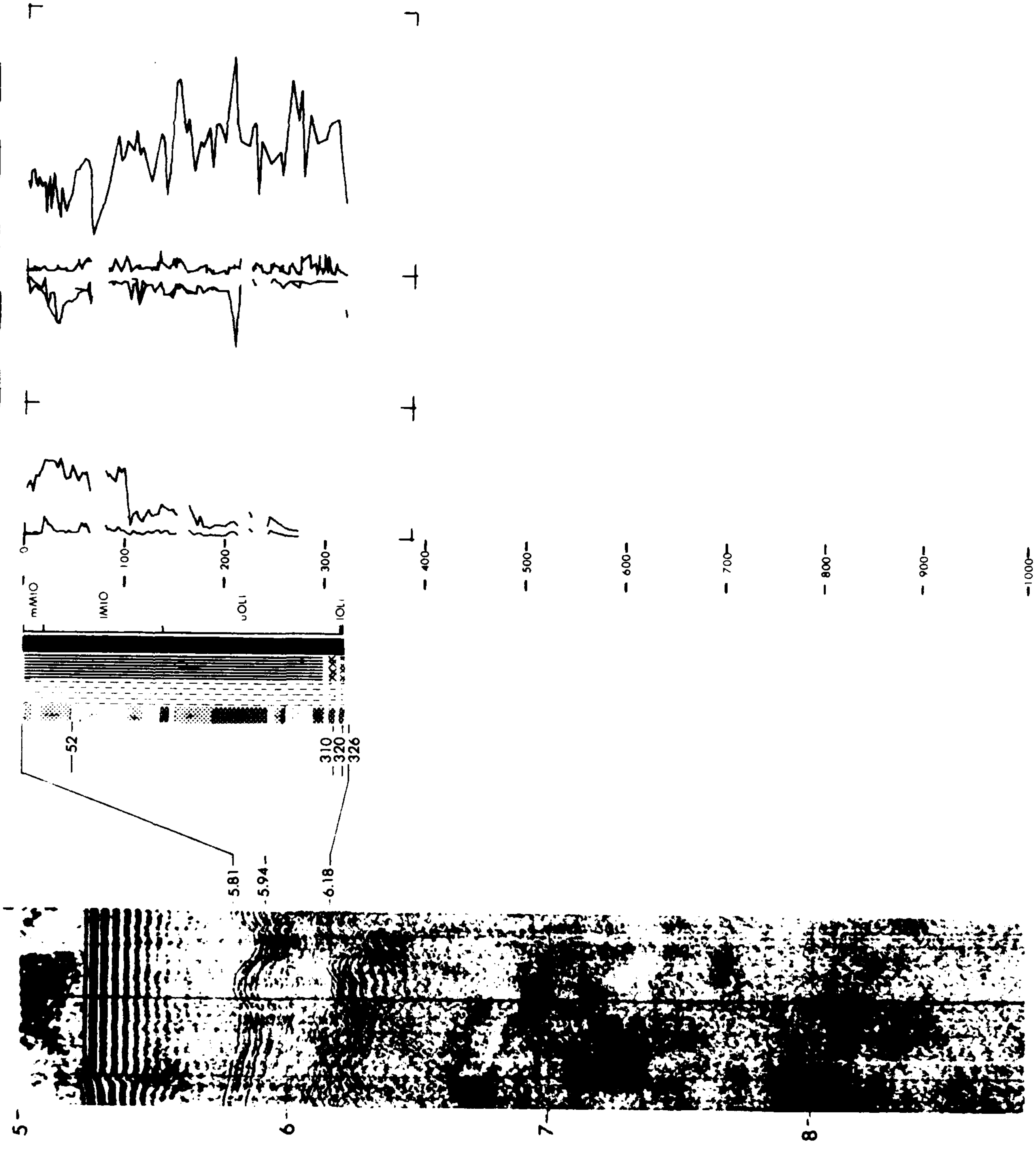
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	7°57.0' N	Drilled--	0 meters
Longitude	127°21.3' W	Cored----	320 meters
Date:	12/25/69	Total----	320 meters
Time:	0400Z	Recovery:	
Water depth:	4378 meters	Basement-	2 cores
Location:	North of the Clipperton Fracture Zone		.03 meters
		Total----	37 cores
			302 meters

The sediments at this site are similar in lithology to those recovered at Site 77 but the upper part of the section from the middle of the Middle Miocene to Recent is missing. There is some reworking of Pleistocene foraminifera into the Middle Miocene faunas of the top several cores suggesting that a very thin veneer of Quaternary might be present but was not recovered. The total absence of sediments younger than middle Miocene could be accounted for if sediments of this age were not deposited at this site or if they had been subsequently eroded. The authors favor the former interpretation. The foraminiferal diversity is reduced in the middle Miocene as compared to the Oligocene and lower Miocene probably due to solution. Also, there is evidence of etching of coccoliths probably indicating solution resulting from slower sedimentation rates. At the bottom of this hole the bit encountered hard limestone. This limestone contained euhedral magnetite and shows signs of being baked. It also contains well-preserved foraminifera, indicating that its genesis is tied to some kind of contact metamorphism. Basalt immediately underlies the limestone. This evidence of baking indicates that the basalt is a sill.

Most calcareous sediments nannofossil rich, rarely foraminifera rich.



SITE 78 LEG 9



0
100
200
300
400
500
600
700
800
900
1000
mMIO
lMIO
uOLI
lOLI
52
310
320
326
5.81
5.94
6.18
5
6
7
8

SITE DATA

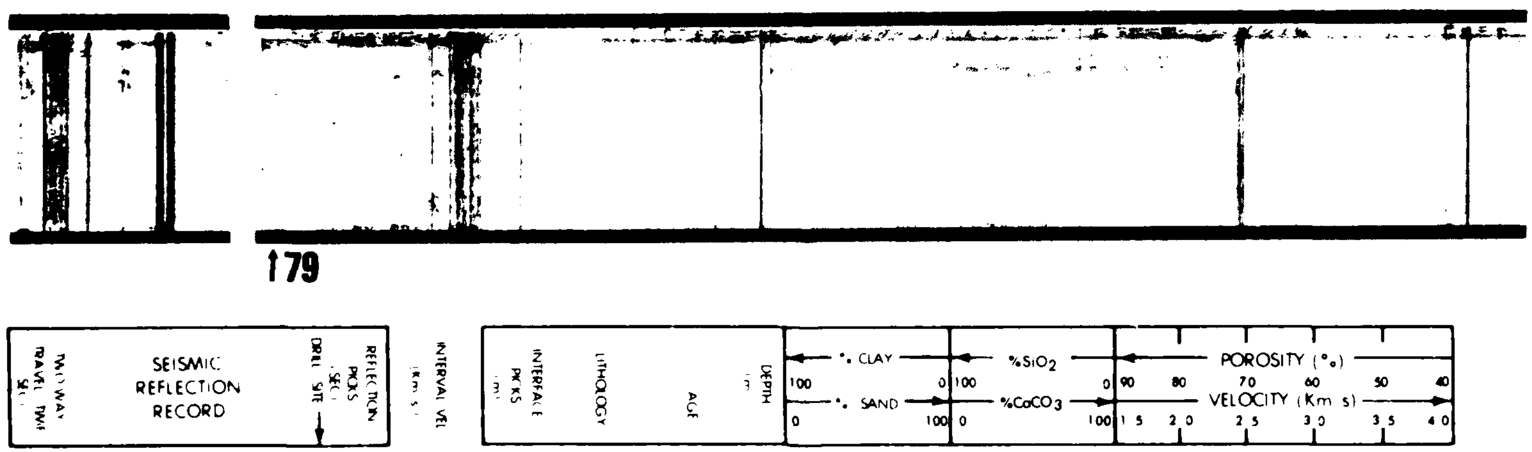
Position:
Latitude 2°33.0' N
Longitude 121°34.0' W
Date: 12/30/69
Time: 2400Z
Water depth: 4574 meters
Location: Equatorial Pacific Sediment Belt

CORE DATA

Penetration:	79	79A	
Drilled--	281	251	meters
Cored----	133	37	meters
Total----	414	288	meters
Recovery:			
Basement-	1	0	cores
	.5	0	meters
Total----	17	4	cores
	121	35	meters

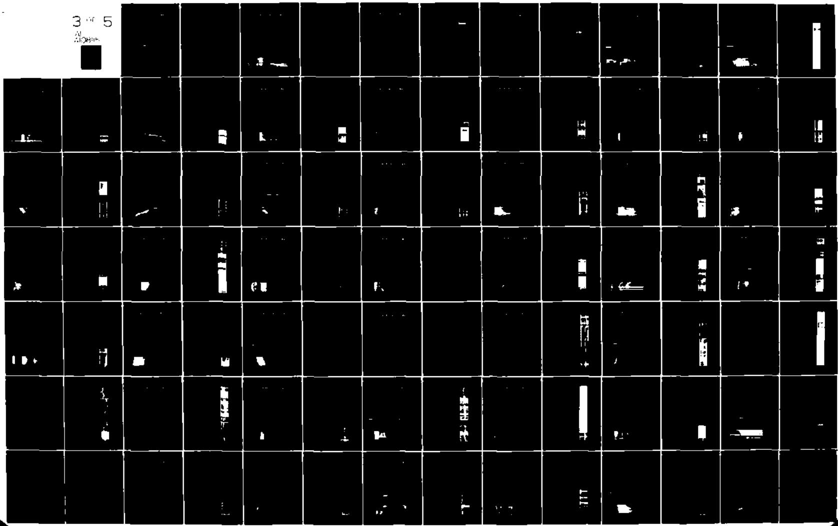
The sediments at this site are similar to those at Sites 77 and 78. At Site 79 the accumulation rates are about 15 m/m.y., except in the Middle Miocene where they are more than double this rate. One explanation for the high rates indicated in the Middle Miocene part of the section is that the productivity in the Middle Miocene time was much greater than either before or since. This phenomenon was not noted at our previous sites. Another possibility is that some local effect, such as slumping during middle Miocene time, caused these high rates although no extraordinary amount of older mixed fossils was found in this part of the section. Using the ages of the oldest sediment at Sites 77 and 79 and the distance between these sites gives a spreading rate of 79.5 km/m.y. The spreading rates between Sites 77 and 78 and between Sites 78 and 79 are very different. Site 78 is north of the Clipperton Fracture Zone and the age of its oldest sediment relative to the distance between it and the longitude lines of Sites 77 and 79 suggest this site has undergone a right lateral displacement relative to Sites 77 and 79 of about 380 kilometers.

Overall sediments nannofossil rich.

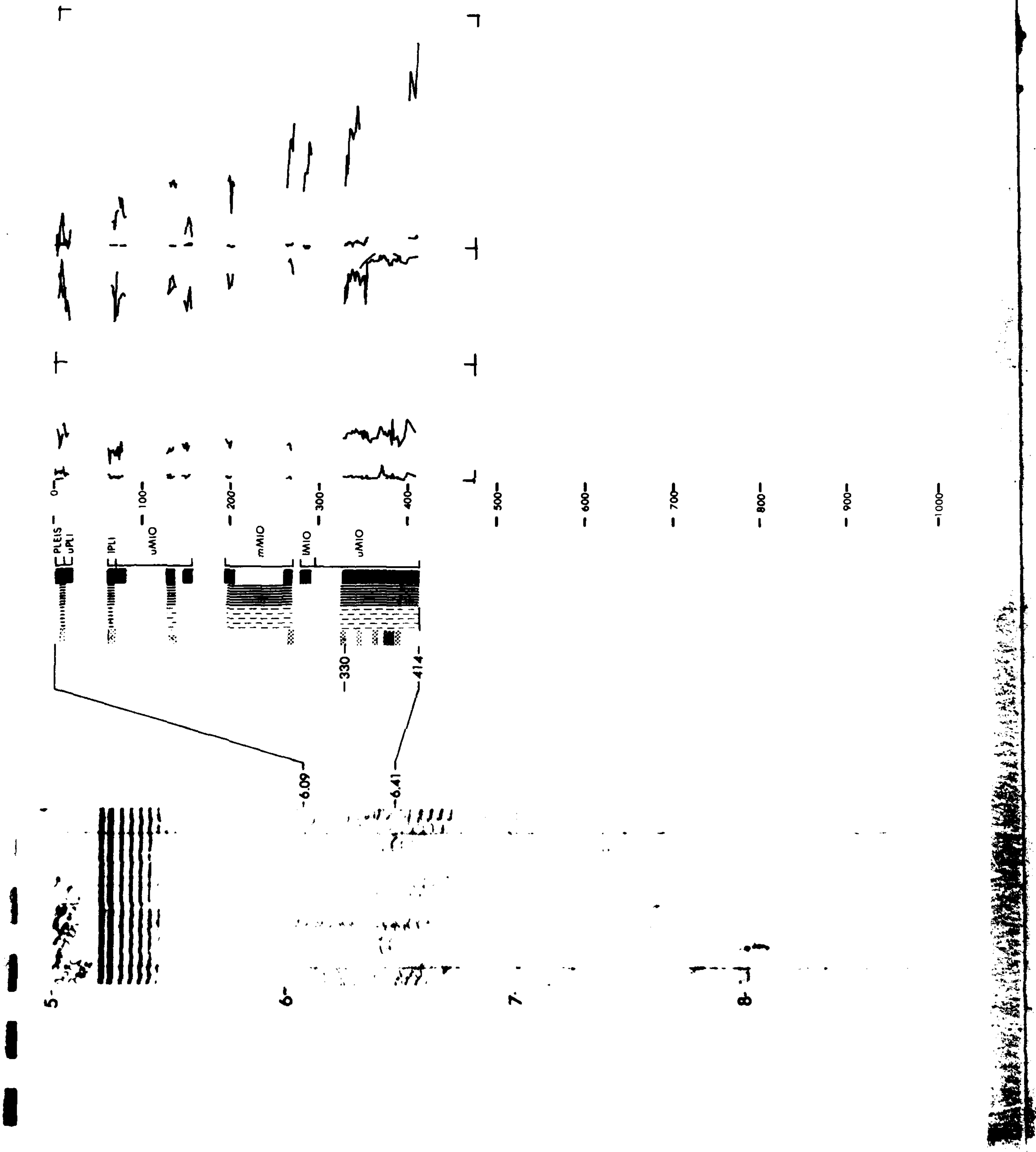


AD-A108 115 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 8/10
A SUMMARY OF SELECTED DATA: DSOP LEGS 1-19.(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL

3 of 5



SITE 79 LEG 9



0
100
200
300
400
500
600
700
800
900
1000
PLEIS
uPLI
lPLI
uMIO
mMIO
lMIO
uMIO
330
414
6.09
6.41
5
6
7
8

SITE DATA

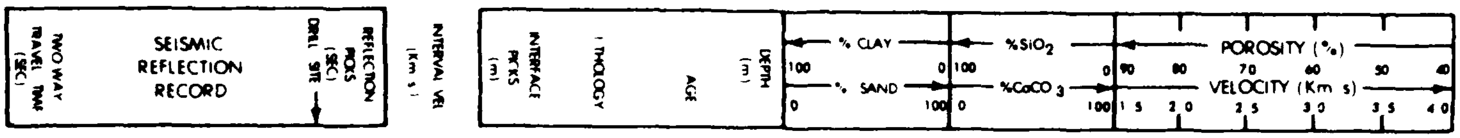
Position:
Latitude 0° 57.7' S
Longitude 121° 33.2' W
Date: 01/04/70
Time: 1200 Z
Water depth: 4411 meters
Location: Equatorial Pacific Sediment Belt

CORE DATA

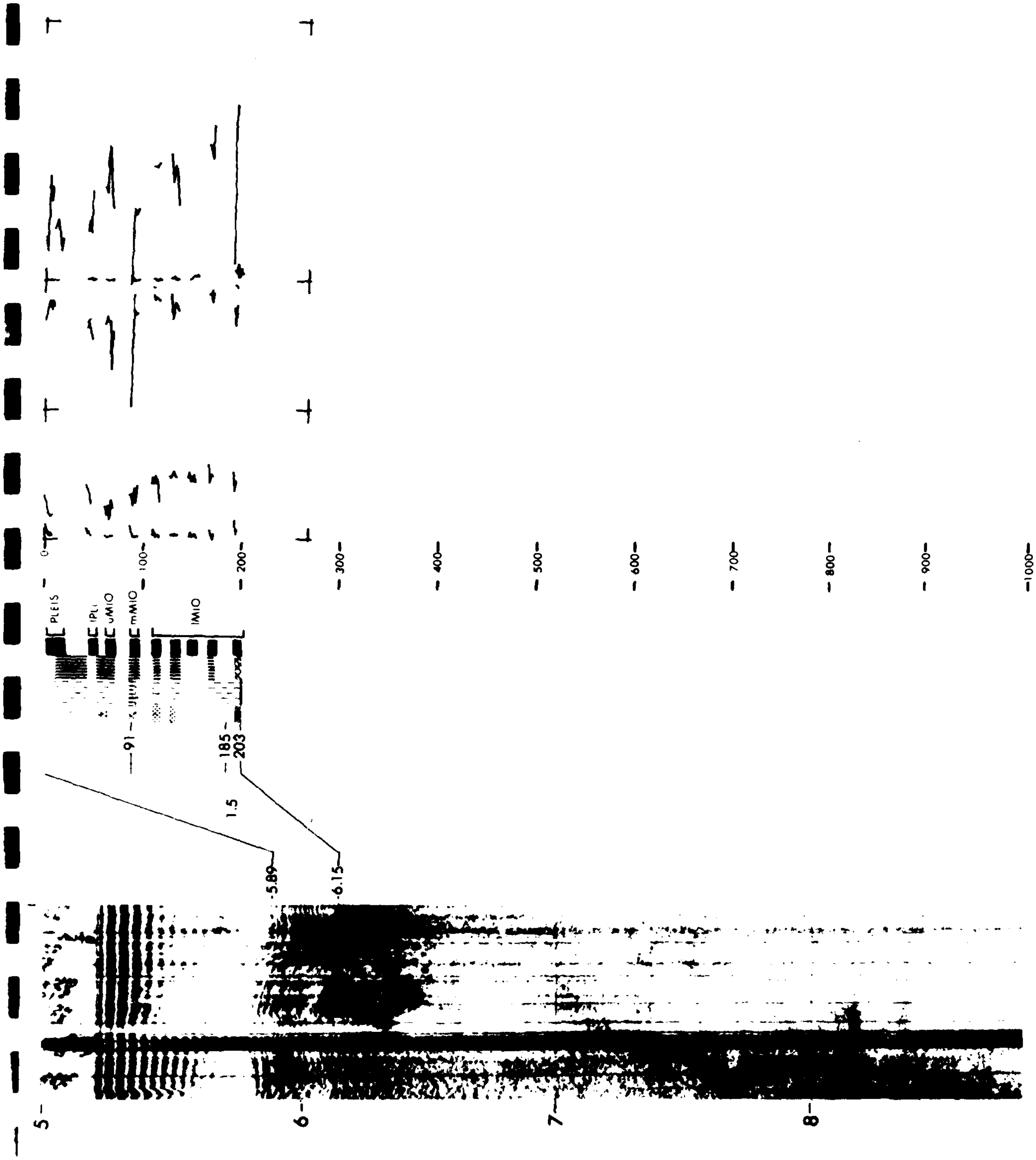
Penetration:	80	80 A	
Drilled--	157	73	meters
Cored----	42	46	meters
Total----	200	118	meters
Recovery:			
Basement-	1	0	cores
	.15	0	meters
Total----	6	5	cores
	40	46	meters

As at previous sites the Pleistocene has a considerably slower rate of deposition than the Pliocene which could be caused in part by our not coring the entire Pleistocene. The Pliocene has the highest sedimentation rate of the section and the Upper and Middle Miocene is considerably slower. The Lower Miocene, while considerably slower than the Pliocene, shows a higher sedimentation rate than the Middle and Upper Miocene. This pattern of sedimentation rates fits the pattern that would be expected if the sea floor at this site during the last 10 to 15 million years had been moving in a West-North-West direction carrying the site into zones of progressively higher productivity. The spreading rate between Sites 77 and 79 of 80 km/10^6 yr is confirmed. The basal sediments at Site 80 are similar to those at Site 77 consisting of nonsiliceous reddish-brown clay. It may be significant that both our southernmost sites (77 and 80) have basal sediments of this type, while the contacts in the other sites are baked limestone or chalk. The origin of this clay may be iron-manganese-rich hydrothermal emanations from the crestal region of the East Pacific Rise.

Overall sediments calcareous, mostly nannofossil rich. One thin bed, siliceous, of middle Miocene time.



SITE 80 LEG 9



PLEIS
lPLI
uMIO
mMIO
lMIO
0
100
200
300
400
500
600
700
800
900
1000
91
185
203
1.5
5.89
6.15
5
6
7
8

SITE DATA

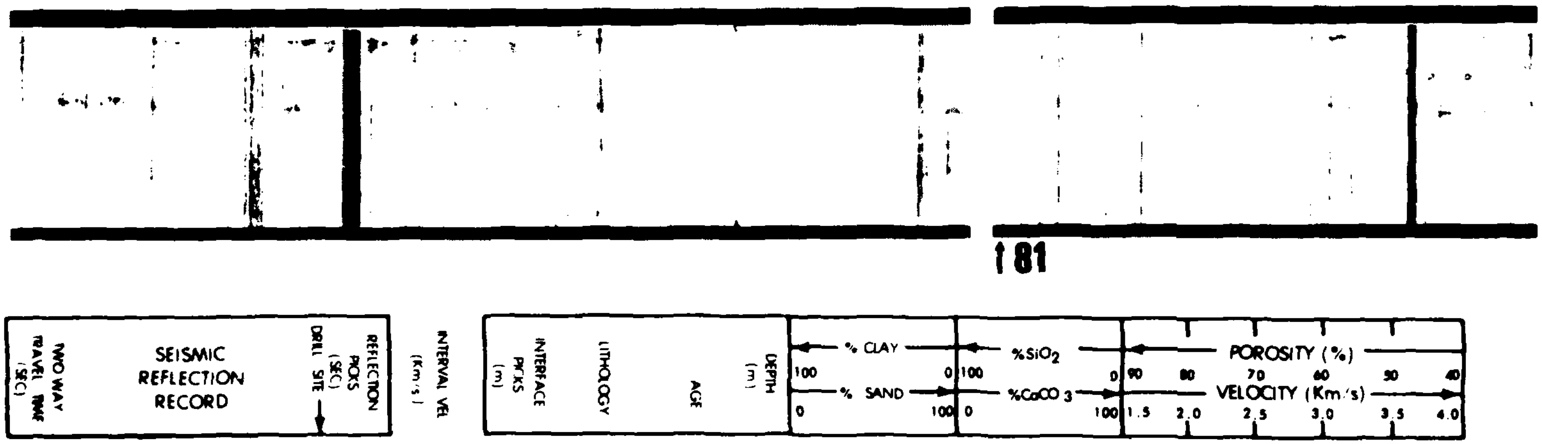
Position:
Latitude 1°26.5' N
Longitude 113°48.5' W
Date: 01/08/70
Time: 1825Z
Water depth: 3865 meters
Location: Equatorial belt near the East Pacific Rise

CORE DATA

Penetration:		
Drilled--	370	meters
Cored----	39	meters
Total----	409	meters
Recovery:		
Basement-	1	cores
	.2	meters
Total----	7	cores
	39	meters

The sediment basalt contact at this site shows signs of alteration in a 2.5 meter thick zone. There is also brecciation near the contact between sediment and basalt indicating that the sediment was broken and twisted as the sill was intruded. Although the precise rate of sediment accumulation at the base of the section is not known, if you use the average rate for the whole section as a first approximation (21 m/10^6 yrs) then the thermally altered section above the contact would have taken about 100,000 years to be deposited. The distance between the longitude lines of Site 79, where the basal sediments have an age of about 21 million years, and the longitude line of Site 81, where the basal sediments have an age of about 14.5 million years, is 806 kilometers. If we assume that the basalt was intruded at or near the sediment basalt interface, so that the age of the basal sediment is similar to that of the basement, then the rate of spreading between these two sites is 124 km/m.y. Using this spreading rate the sill was intruded a minimum distance from the ridge crest of 12.4 kilometers.

Cored sediments mostly nannofossil rich.



SITE 81 LEG 9

5

6

7

8

SITE DATA

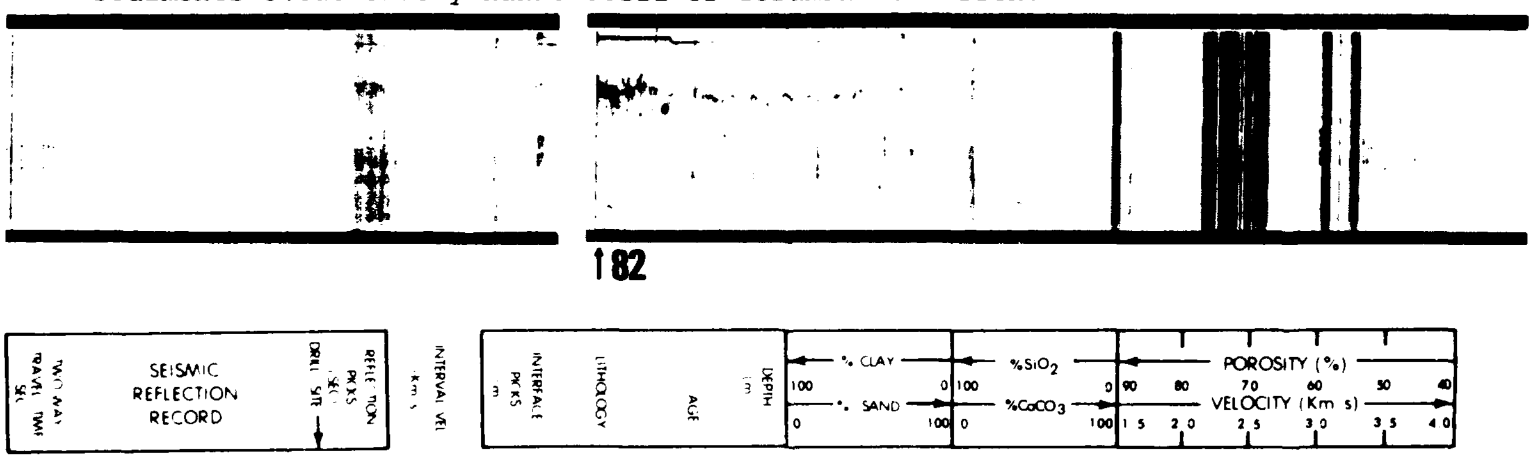
Position:
Latitude 2°35.5'N
Longitude 106°56.5'W
Date: 01/13/70
Time: 0314Z
Water depth: 3707 meters
Location: East Pacific Rise

CORE DATA

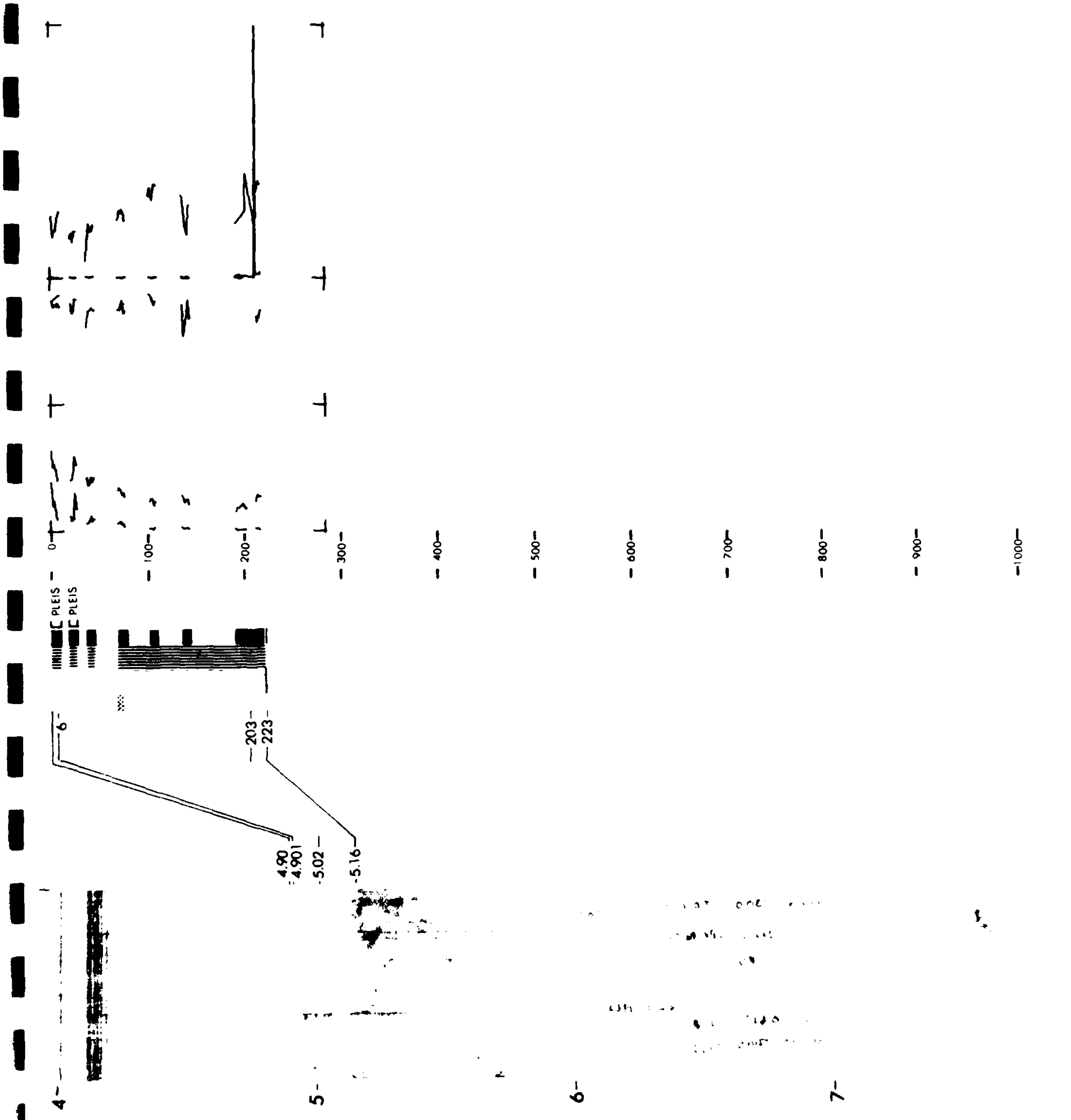
Penetration:	82	82A	
Drilled--	164	83	meters
Cored----	50	27	meters
Total----	214	111	meters
Recovery:			
Basement-	1	0	cores
	.3	0	meters
Total----	7	3	cores
	46	26	meters

The sediments at this site differ from those at the previous site in that the upper few meters are a rich chocolate brown ("red") clay that grades downward into a green ooze. Calcium carbonate content increases with depth. The sediments just above basement are tan clay devoid of Radiolaria but containing calcareous fossils. These tan sediments show brecciation, suggesting movement. At this site the basement again appears to be a sill that has intruded the sediment. The rates of deposition are slowest at the top and increase toward the bottom. This is the kind of pattern that might be expected if this site had moved in a west-north-west direction, thereby moving the site continuously away from the high productivity axis centered on the equator. The average sedimentation rate for the site is 24.3 m/m.y. The rate of sea floor spreading between Site 81 and 82 is about 133 km/m.y. Giving the ridge crest a zero age would indicate a spreading rate of 61 km/m.y. during the last 9 million years, indicating a fairly abrupt decrease in spreading rates. This change in rate was probably accompanied by a change in direction from a generally east-west direction to a more west-northwest direction.

Sediments occasionally nannofossil or foraminifera rich.



SITE 82 LEG 9


PLEIS
PLEIS
0
100
200
300
400
500
600
700
800
900
1000
6
203
223
4.90
4.901
5.02
5.16
4
5
6
7

SITE DATA

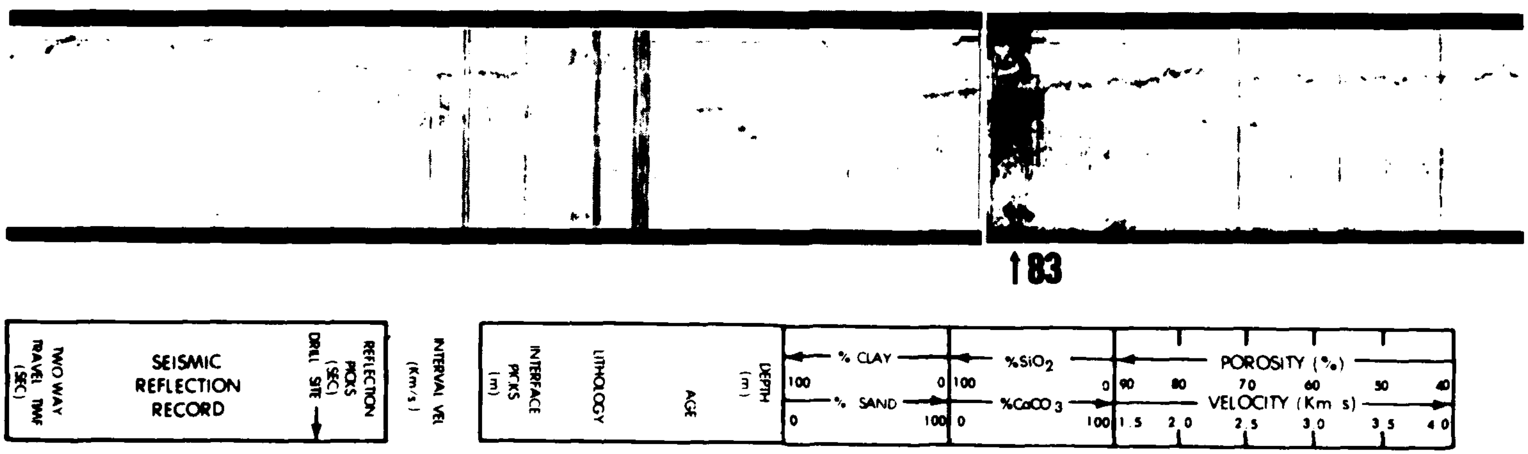
Position:
Latitude 4°02.8'N
Longitude 95°44.2'W
Date: 01/17/70
Time: 1742Z
Water depth: 3646 meters
Location: East of East Pacific Rise

CORE DATA

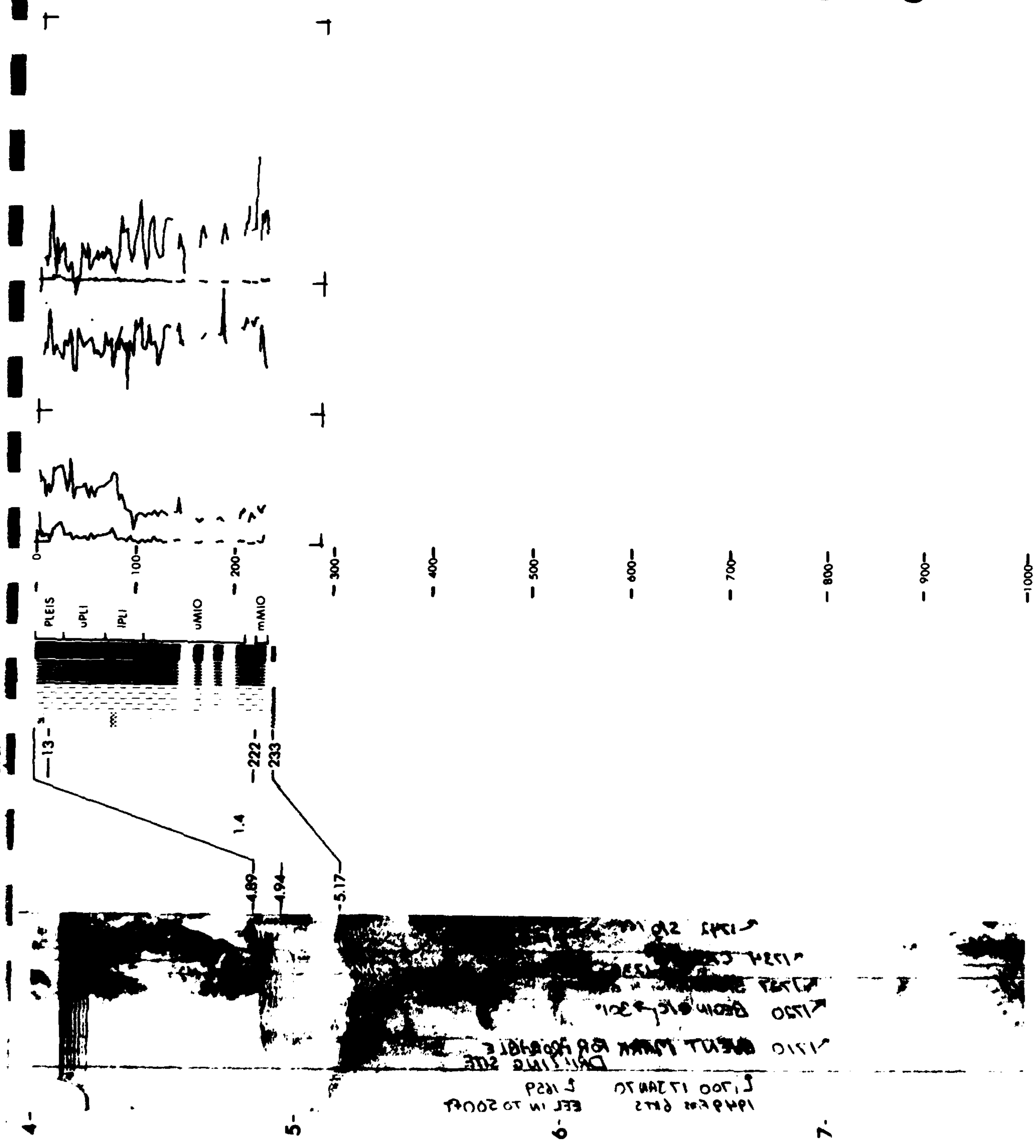
Penetration:	83	83A	
Drilled--	180	73	meters
Cored----	61	146	meters
Total----	241	219	meters
Recovery:			
Basement-	1	0	cores
	.15	0	meters
Total----	9	16	cores
	47	141	meters

The rates of sedimentation at this site are uniform throughout. This constancy may be interpreted in two ways: either the belt of high productivity in this easternmost part of the equatorial Pacific is quite broad, therefore having a low meridional gradient, or the motion at this site since Middle Miocene has been predominantly east-west, parallel to the productivity gradient. The sediment at the top of the section is a dark reddish-brown clay that grades downward to a dark green radiolarian ooze which in turn becomes increasingly calcareous with depth. We can probably safely conclude that the amount of north-south movement has been small since the rate of deposition at the base never reaches the 27.0 m/m.y. recorded in the Upper Miocene part of Site 82. If we assume an age of 11 million years for the base of Site 83 and a distance to the ridge crest of 797 kilometers then the spreading rate is about 71 km/m.y., which is approximately the same as the 61 km/m.y. calculated between Sites 82 and the ridge crest on the western flank of the ridge. As at the previous sites on Leg 9 the sediments above basement show evidence of baking and at Site 83, as at 82, they show evidence of brecciation.

Sediments nannofossil rich.



SITE 83 LEG 9



0
100
200
300
400
500
600
700
800
900
1000
PLEIS
uPLI
lPLI
uMIO
mMIO
13
222
233
1.4
4.89
4.94
5.17
4
5
6
7

SITE DATA

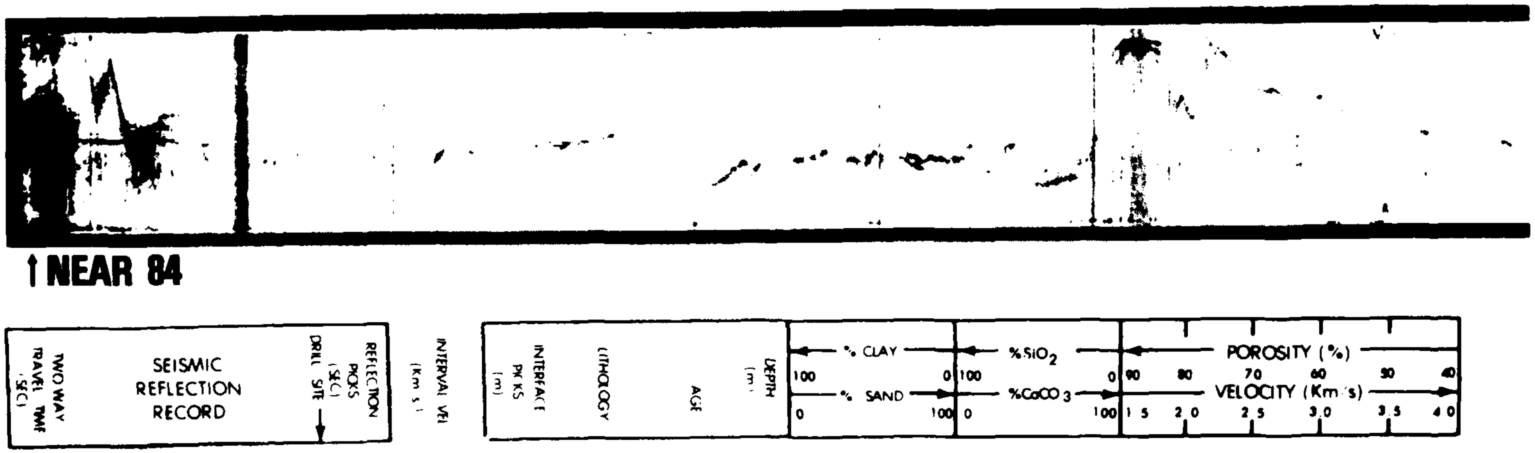
Position:
    Latitude $5°44.9'$ N
    Longitude $82°53.3'$ W
Date: 01/23/70
Time: 1745Z
Water depth: 3096 meters
Location: Near Coast of Panama

CORE DATA

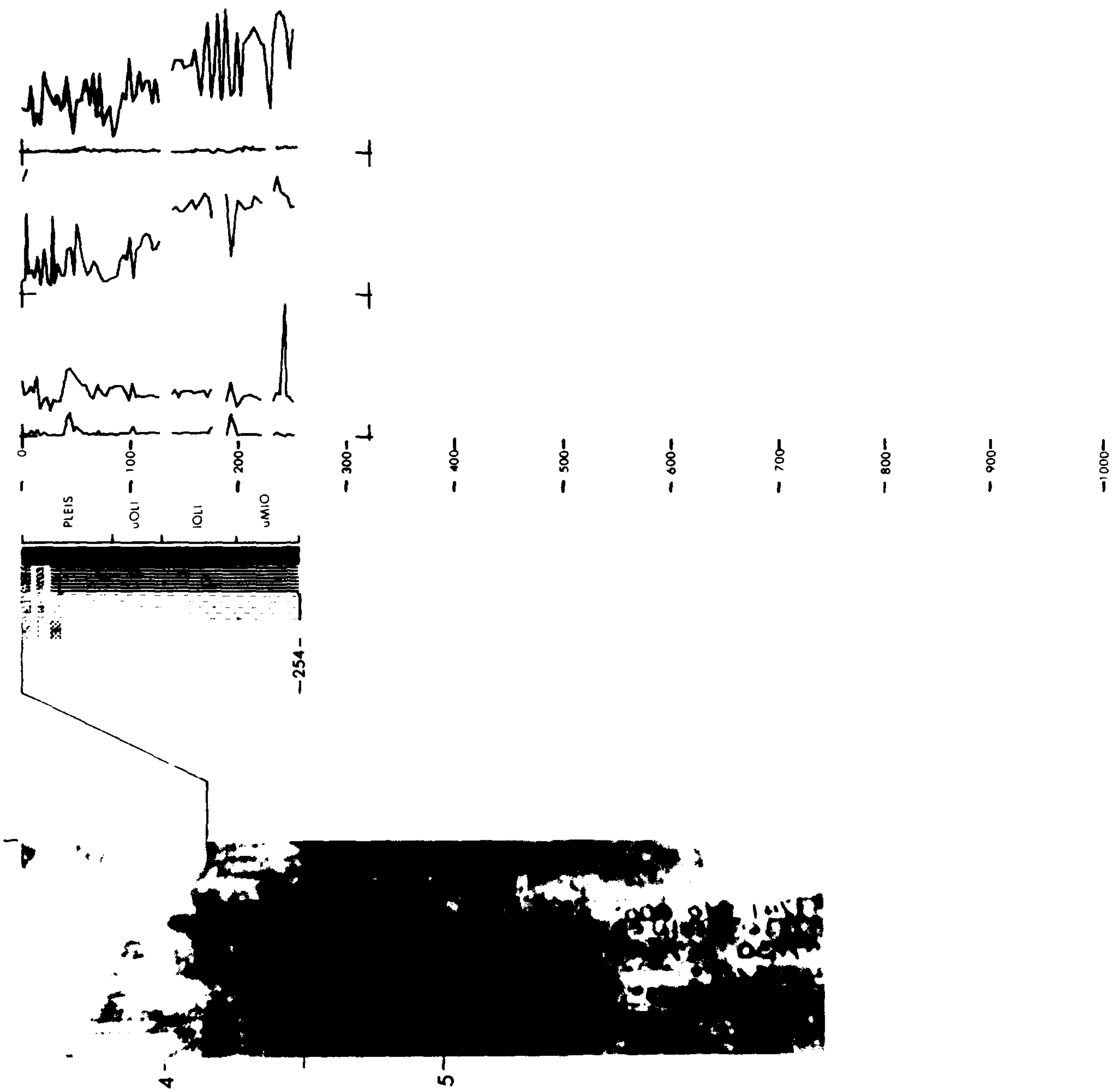
Penetration:
    Drilled-- 0 meters
    Cored---- 254 meters
    Total---- 254 meters
Recovery:
    Basement- 1 cores
    .15 meters
    Total---- 30 cores
    214 meters

The rates of accumulation are highest in the Pleistocene, and decrease with increasing age. The Pleistocene sediments are green oozes with an admixture of continentally derived material, primarily volcanic glass. Discrete ash layers occur within the Pleistocene section but not below. The carbonate content increases with depth. The high rates of sedimentation in the Pleistocene are attributed to the influx of material from continental sources. The increasing rates of accumulation with decreasing age can be explained by two alternatives. One possibility is increasing elevation and volcanism in Panama. A second possibility is that the motion of the sea floor during the time represented by the sediments at this site caused the site location to move closer to Panama, thereby bringing it progressively into regions of higher depositional rates. The basalt/sediment contact at this site was altered. A thin layer of chert overlies the basalt and a layer of glauconite immediately overlies a chilled glassy basalt. The alteration of the sediments at this site is different from that at previous sites. This may be due to a different kind of intrusion or sediment, or both.

In general, sediments interbedded calcareous and siliceous. Calcareous sediments, nannofossil rich.



SITE 84 LEG 9



SITE DATA

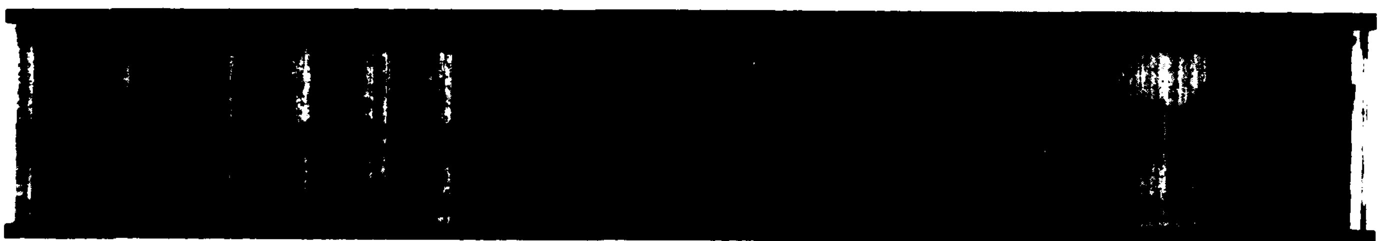
Position:
- Latitude 22°50.5' N
- Longitude 91°25.4' W

Date: 02/23/70
Time: 1050z
Water depth: 3749 meters
Location: Campeche Scarps; Gulf of Mexico

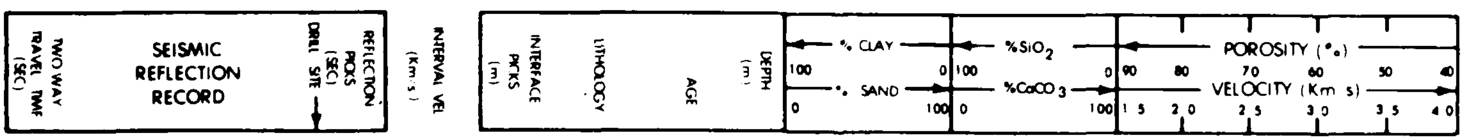
CORE DATA

Penetration:	85	85A	
Drilled--	174	263	meters
Cored----	39	39	meters
Total----	213	302	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	5	2	cores
	25	0	meters

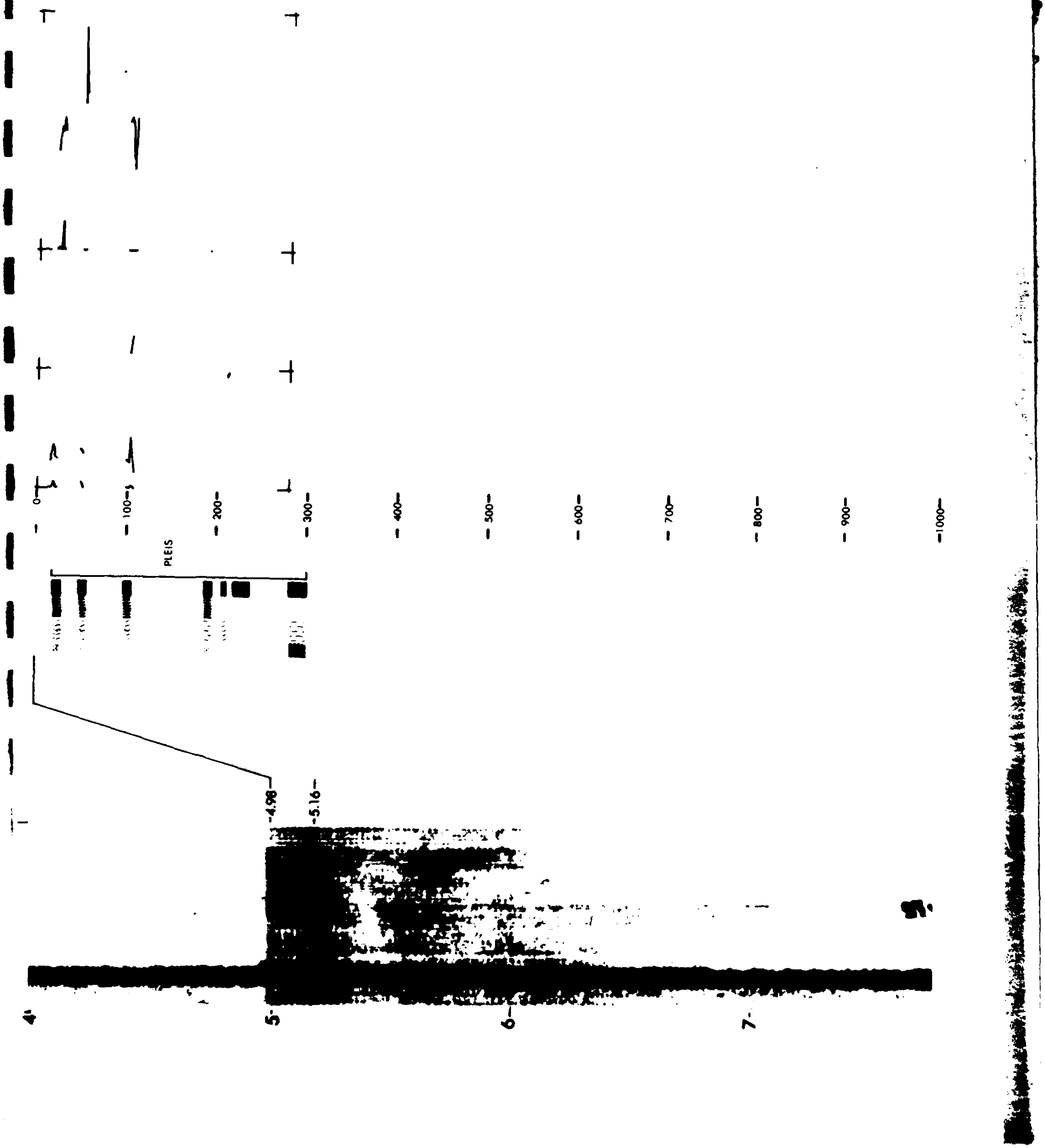
The terrigenous-derived clastics recovered in the upper three cores and in Core 5 are interpreted as turbidites and turbidity-current related deposits (laminites and hemilaminites). On the basis of mineralogy, textural composition, and age, the most likely source of these sediments can be identified as the Mississippi Fan or northern Gulf of Mexico continental slope complex. Late Pleistocene in age, such sediments are essentially identical to documented glacial cold cycle (maximum lowering of sea level) abyssal plain sediments from other localities in the Gulf of Mexico. The lower sequence of carbonates at Site 85 appears to be largely a reflection of contribution of carbonate debris from the nearby Campeche Scarp and Yucatan platform. The presence of pelagic ooze (upper Core 4) suggests that intermittent pelagic conditions occurred in proximity to the site during Pleistocene time. The presence of minor nannofossil-rich clay in the upper part of the sequence (Cores 1-3) likewise suggests infrequent periods of quiescence or slow deposition during Late Pleistocene time.



↑85



SITE 85 LEG 10



SITE DATA

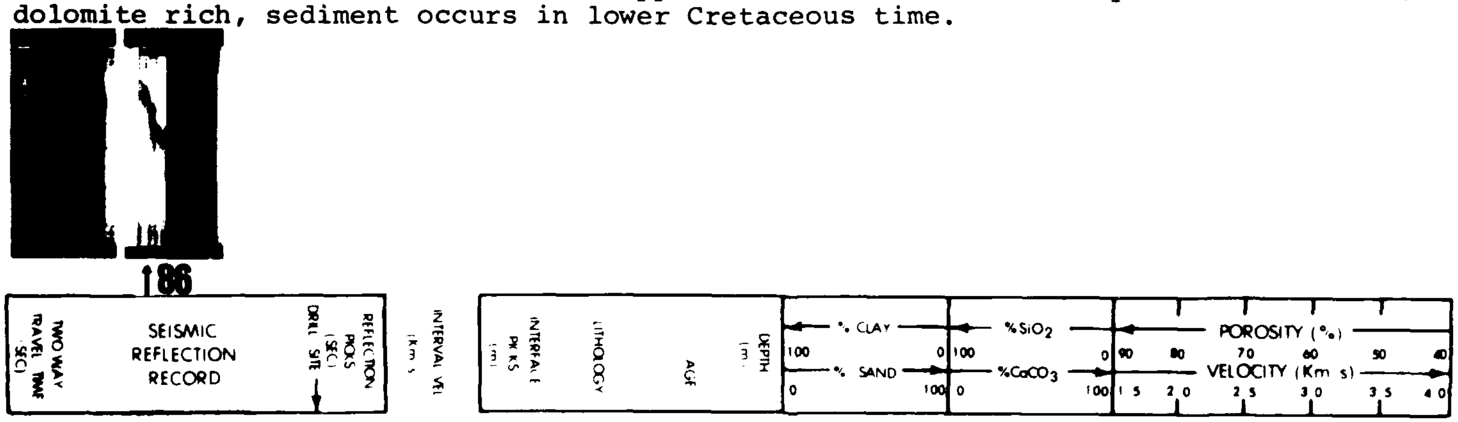
Position:
Latitude $22°52.5'$ N
Longitude $90°57.7'$ W
Date: 02/25/70
Time: 0180Z
Water depth: 1481 meters
Location: Campeche/Yucatan slope

CORE DATA

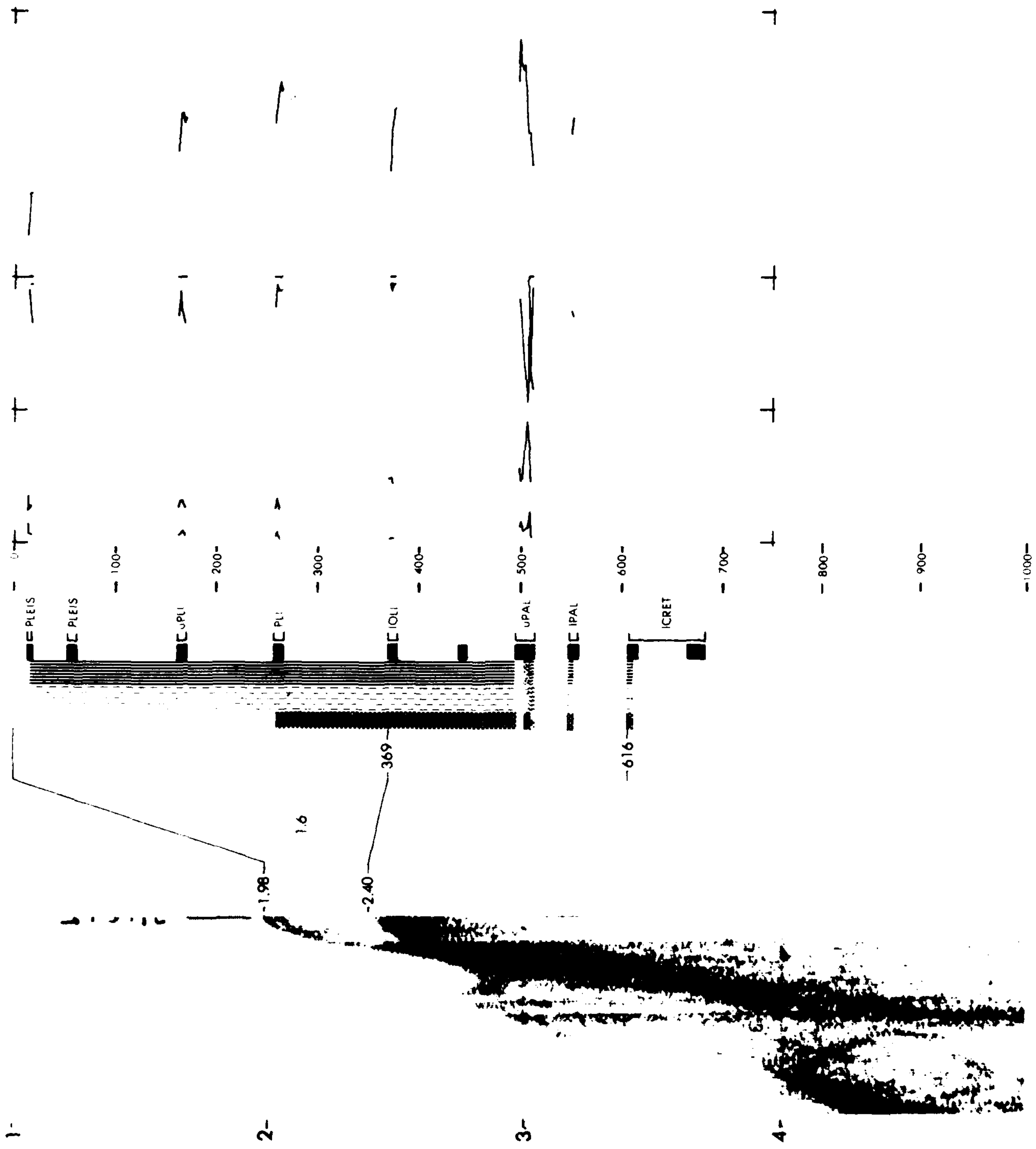
Penetration:
Drilled-- 582 meters
Cored---- 104 meters
Total---- 686 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 14 cores
42 meters

The presence of carbonate biogenic debris as a dominant constituent, the planktonic aspect of the faunal elements represented, the intensity of burrowing, and the absence of terrigenous clastic elements support a pelagic origin for the Cenozonic sediments. The basal sequence of brown dolomites is somewhat problematical in terms of age and environmental/depositional setting. It may be concluded that the dolomites represent initially shallow-water carbonate rock types, subsequently altered and recrystallized in dolomitization. This portion of the Campeche/Yucatan slope has been the site of pelagic sedimentation since at least the start of Tertiary time. No apparent changes in water depth are evident on the basis of sediment type within the Tertiary section, and, indeed, the basal Paleocene sediments resemble deep-sea red clays in many respects. Origin of the Early (?) Cretaceous dolomites appears related to an earlier period of shallow-water carbonate sedimentation and subsequent alteration. The presence of Cretaceous shallow-water skeletal calcarenites can be demonstrated on the basis of clasts recovered at Site 85, as well as at Sites 94 and 95. On the basis of superposition, it can thus be postulated that a general period of subsidence has occurred on the outer Yucatan platform following Early Cretaceous time.

Calcareous, nannofossil rich, sediments. Thin layers of detrital, serpentine rich, and detrital sediments occur in the upper Paleocene. One thin layer of calcareous, dolomite rich, sediment occurs in lower Cretaceous time.



SITE 86 LEG 10



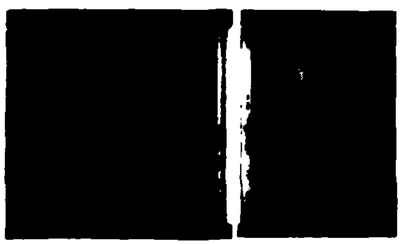
SITE DATA

Position:
Latitude 23°00.9' N
Longitude 92°05.2' W
Date: 02/27/70
Time: 1445Z
Water depth: 3761 meters
Location: Sigsbee Basin

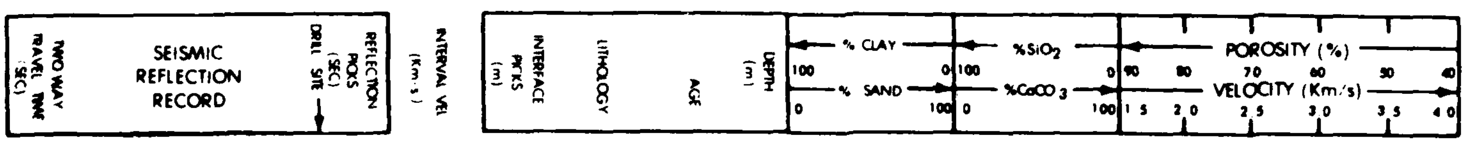
CORE DATA

Penetration:
Drilled-- 691 meters
Cored---- 9 meters
Total---- 700 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 1 cores
2.5 meters

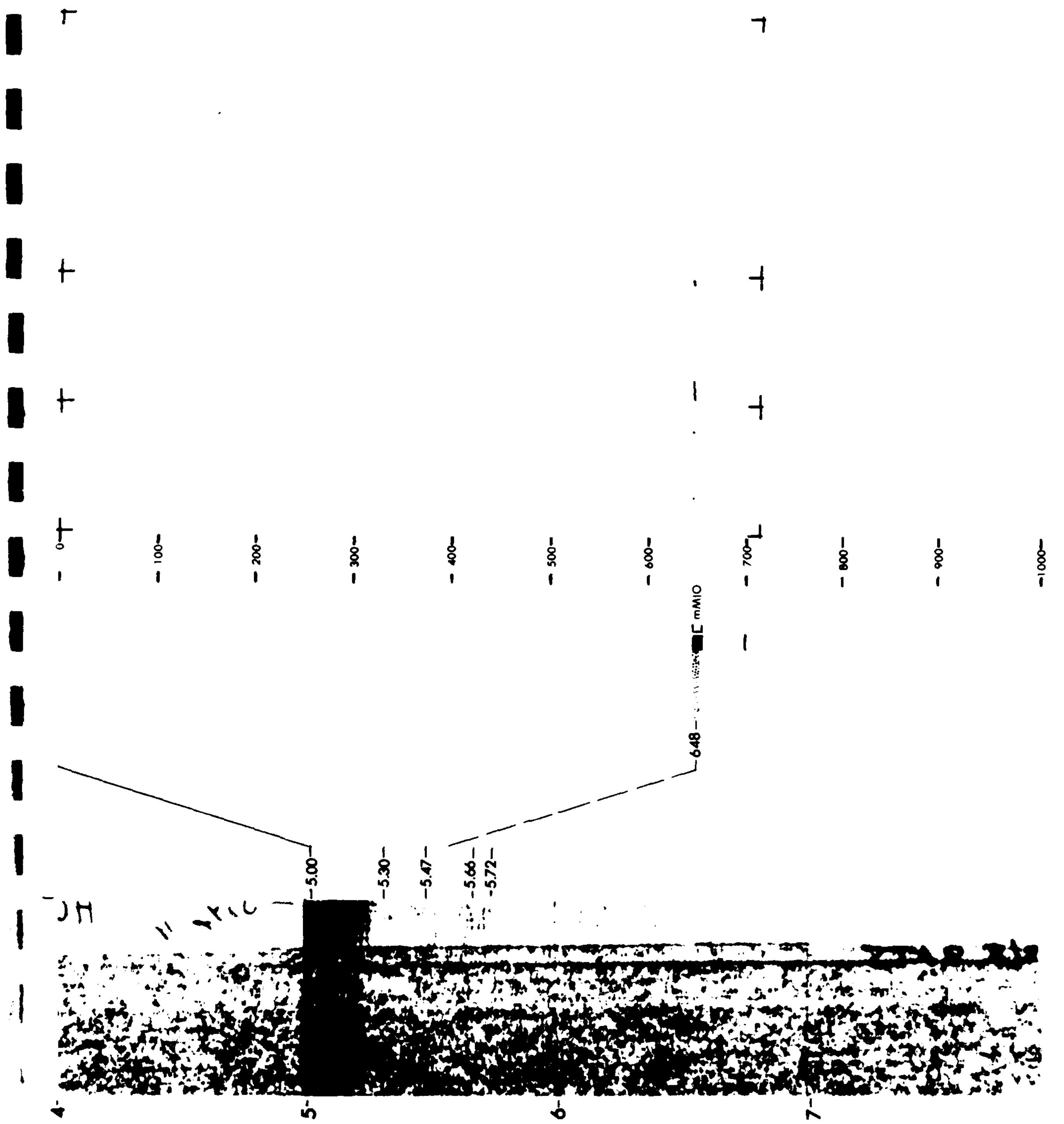
The presence of texturally coarse graded beds with sharp basal contacts intercalated with faintly laminated, sparsely burrowed, silty clay or clay suggests deposition as turbidites with associated laminites. The occurrence of horizontal laminae within the coarse units (although moderately disturbed, some can be observed), the presence of dispersed mudclasts up to several centimeters in size, and the presence of abundant carbonaceous debris support the interpretation. The sediments can be interpreted as a continuation of turbidite-dominated sedimentation first encountered at about 600 meters in Site 3, Leg 1. This appears to correspond with relationships noted on the profiler records and suggests that continuation of turbidites and associated sediments to a depth well below 700 meters is a valid interpretation. The compositional immaturity of the sands and a marked similarity to equivalent age sands at Sites 90 and 91 would indicate a provenance to the northwest.



187



SITE 87 LEG 10



SITE DATA

Position:
Latitude $21^{\circ}22.9'$ N
Longitude $94^{\circ}00.2'$ W
Date: 03/03/70
Time: 2130Z
Water depth: 2532 meters
Location: Bay of Campeche

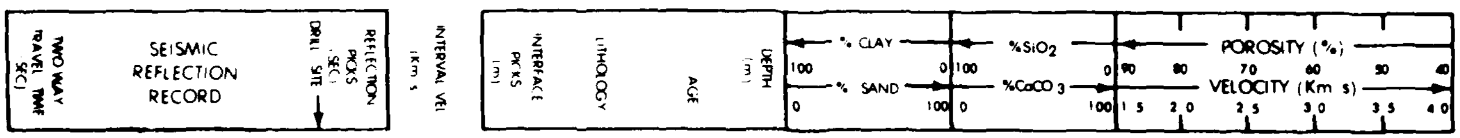
CORE DATA

Penetration:		
Drilled--	100	meters
Cored----	35	meters
Total----	135	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	5	cores
	33	meters

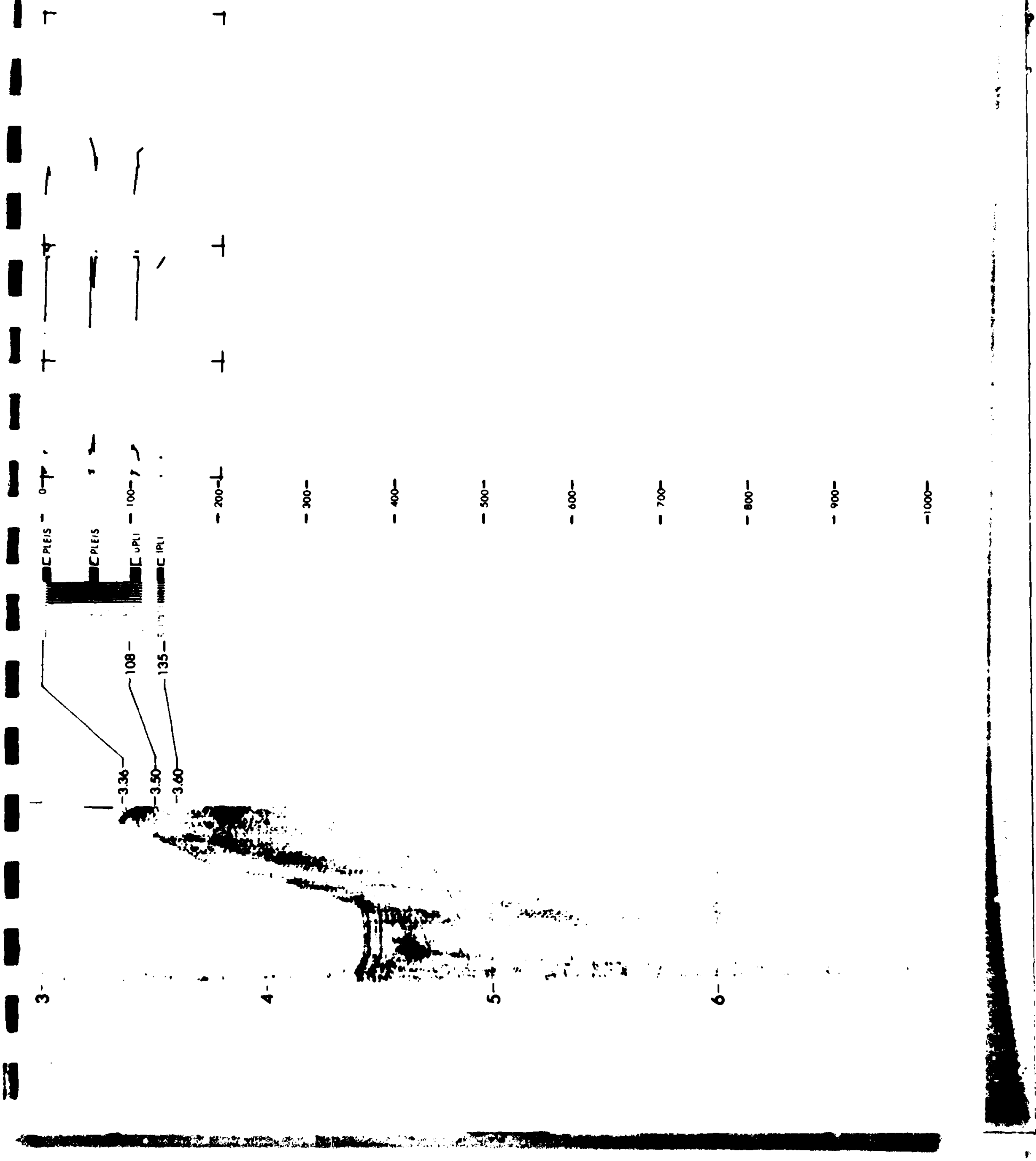
As at Site 86, the presence of carbonate biogenic debris as a dominant constituent, the planktonic aspect of the faunal elements represented, the intensity of burrowing, and the general absence of normal terrigenous clastic elements support a pelagic origin for the sediments described. Comparison of this hole with Site 2 of Leg 1, also on the crest of a bathymetric high (probable salt diapir), suggests strong similarities in depositional setting. The only important difference in sediment appears to be in the greater abundance of volcanogenic debris at Site 88. It should also be pointed out that the sediment type at Site 88 is quite comparable to that recovered from Site 86. Site 88 has apparently been the site of pelagic sedimentation since at least Early Pliocene time. On the basis of the profiler record and the lack of other sediment types, it can be concluded that little, if any, change in water depth or setting has taken place since that time. In view of the undrilled sediment evident from the profiler record, it can be postulated that the record of pelagic sedimentation may ultimately extend considerably further back in time at Site 88.

Some sediment; nannofossil rich.

↑88



SITE 88 LEG 10



SITE DATA

Position:
- Latitude $20^{\circ}53.4'$ N
- Longitude $95^{\circ}06.7'$ W

Date: 03/05/70
Time: 1215Z
Water depth: 3067 meters
Location: Bay of Campeche

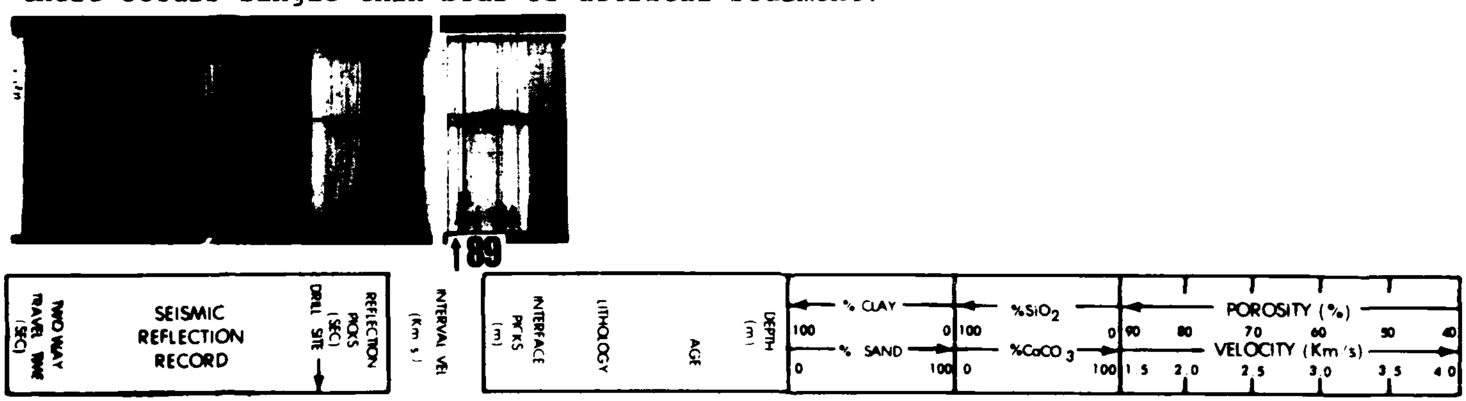
CORE DATA

Penetration:
- Drilled-- 404 meters
- Cored---- 36 meters
- Total---- 440 meters

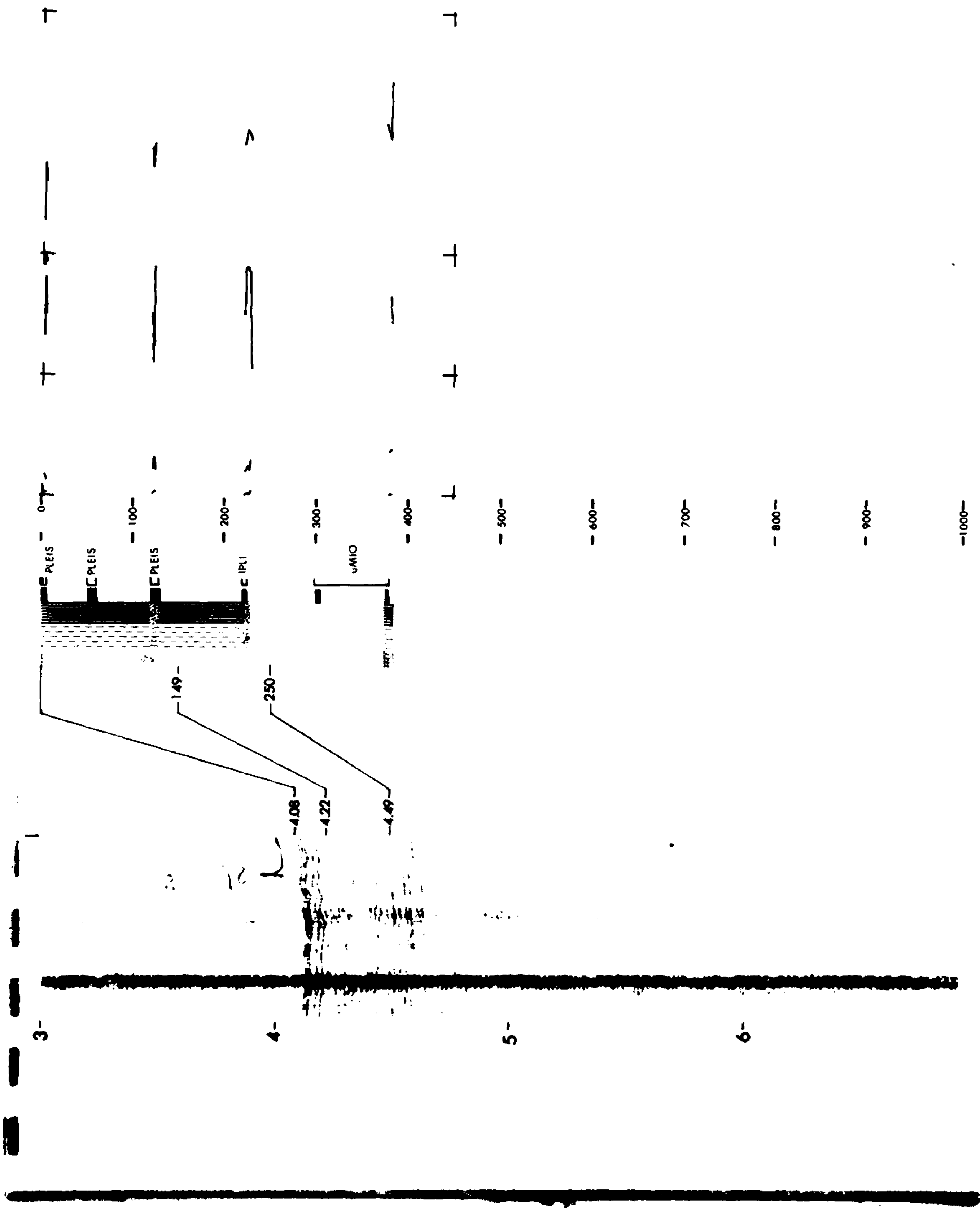
Recovery:
- Basement- 0 cores, 0 meters
- Total---- 6 cores, 26 meters

Sedimentation on the continental rise in the vicinity of Site 89 has been dominated by pelagic processes since at least late Late Miocene time. The abundance of volcanic ash debris suggests proximity to a source which is quite different from the situation at Site 88 and a change in sediment type, (Core 6) suggests that during middle Late Miocene (and older) sedimentation, the continental rise at this locale, was dominated by low energy turbidity currents. These sediments, described as laminites and hemilaminites/ hemipelagites, represent a period of increased sediment influx into the basin as well as into this locale. The turbidite-dominated Miocene sections at Sites 3, 87, 90, and 91 reflect a contemporaneous high rate of sedimentation on the abyssal plain to the north of Site 89. The portion of the continental slope and rise referred to as the Veracruz Gap is here considered as a probable primary axis of sediment transport during at least Miocene time. Site 89, somewhat perophercal to the Gap and on the easterly dipping segment of the continental rise, would thus occupy a rather peripheral position with respect to the introduction of turbidites into the abyssal plain. The abundance of volcanic debris throughout the sequence is also strongly in favor of proximity to a volcanogenic source terrain, e.g., mainland Mexico.

Calcareous sediment; nannofossil rich. In lower Pleistocene and lower Pliocene there occurs single thin beds of detrital sediment.



SITE 89 LEG 10



SITE DATA

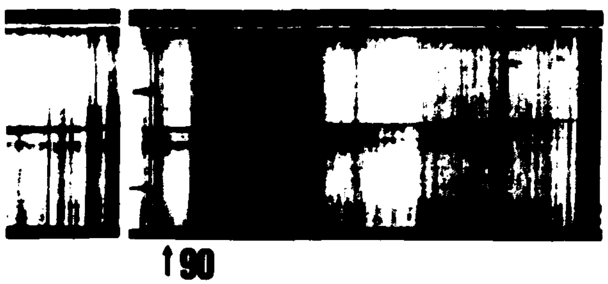
Position:
Latitude 23°47.8' N
Longitude 94°46.1' W
Date: 03/08/70
Time: 2230Z
Water depth: 3713 meters
Location: Sigsbee Basin

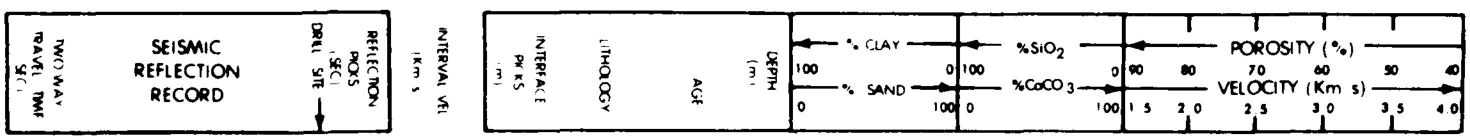
CORE DATA

Penetration:
Drilled-- 682 meters
Cored---- 86 meters
Total---- 768 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 13 cores
57 meters

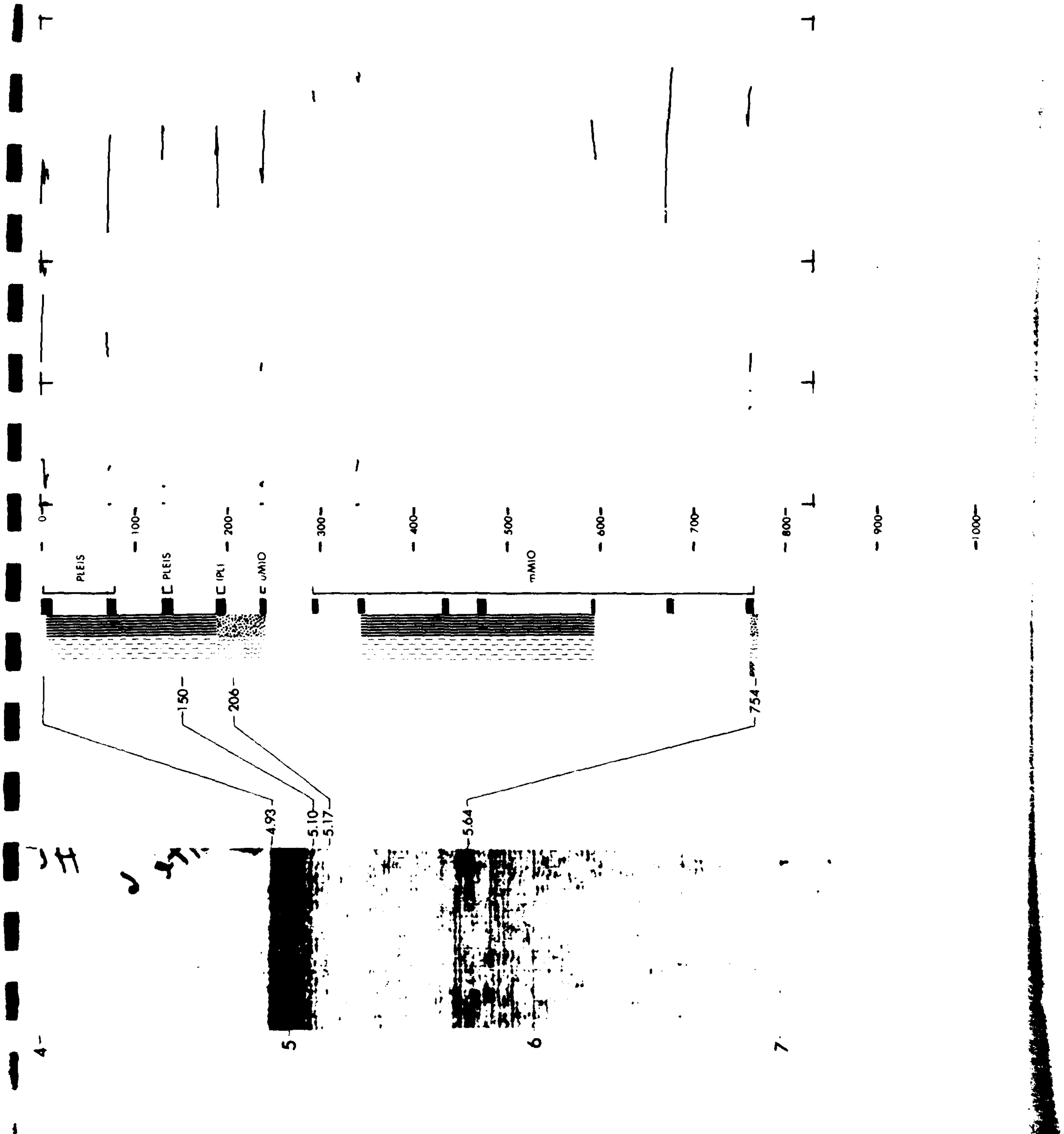
The lithological assemblage of turbidites, laminites, and hemilaminites describes a slow decrease in sedimentation rates from a maximum in (early) Middle Miocene time to a minimum in Pliocene and Early Pleistocene time. This change corresponds to a decrease in abundance of graded sand beds and a probable more local distribution of fine-grained silty clay/clay (as in the hemilaminites). Aggradation and progradation of this latter sediment type evidently produced the ramp which now forms the base of the continental rise along the western Gulf of Mexico slope-abyssal plain transition. Proximity of this site to the Rio Grande embayment suggests that area as the most likely immediate source of such detritus. Following deposition of Miocene sediments, a lower rate of terrigenous clastic influx to the area was operative. Lower Pleistocene(and Upper Pliocene?) sediments are decidedly more pelagic in composition, suggesting that turbidity currents from the east were not able to reach this area (due to a topographically high position?). In Late Pleistocene time, a mixed sequence of turbidity-current related sediments were deposited. Uppermost Pleistocene and Holocene sediments are characteristically laminites and pelagites, respectively.

Middle Miocene detrital sediments mica rich.





SITE 90 LEG 10



SITE DATA

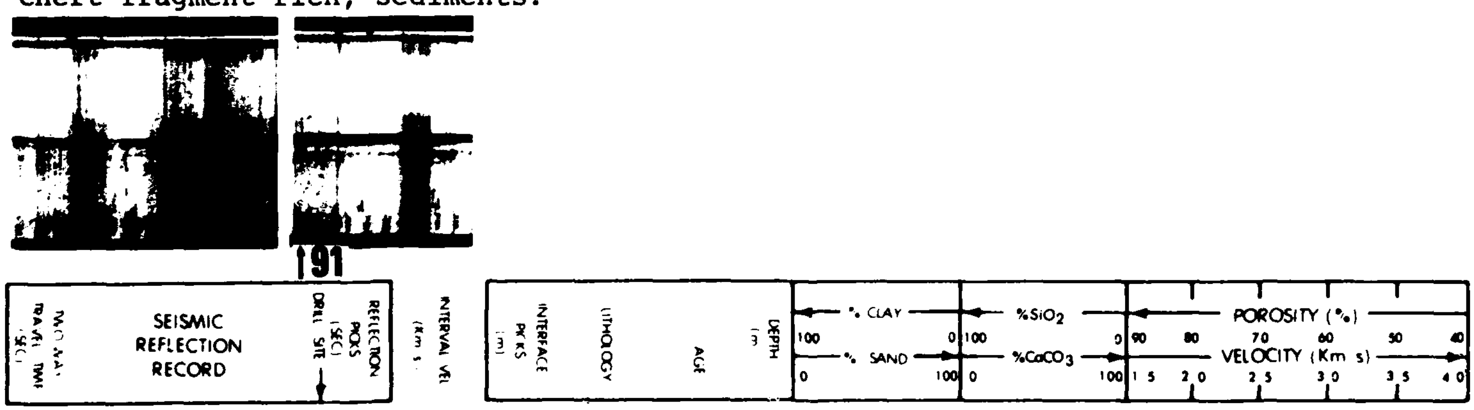
Position:
Latitude 23°46.4′ N
Longitude 93°20.8′ W
Date: 03/11/70
Time: 2100Z
Water depth: 3763 meters
Location: Sigsbee Basin

CORE DATA

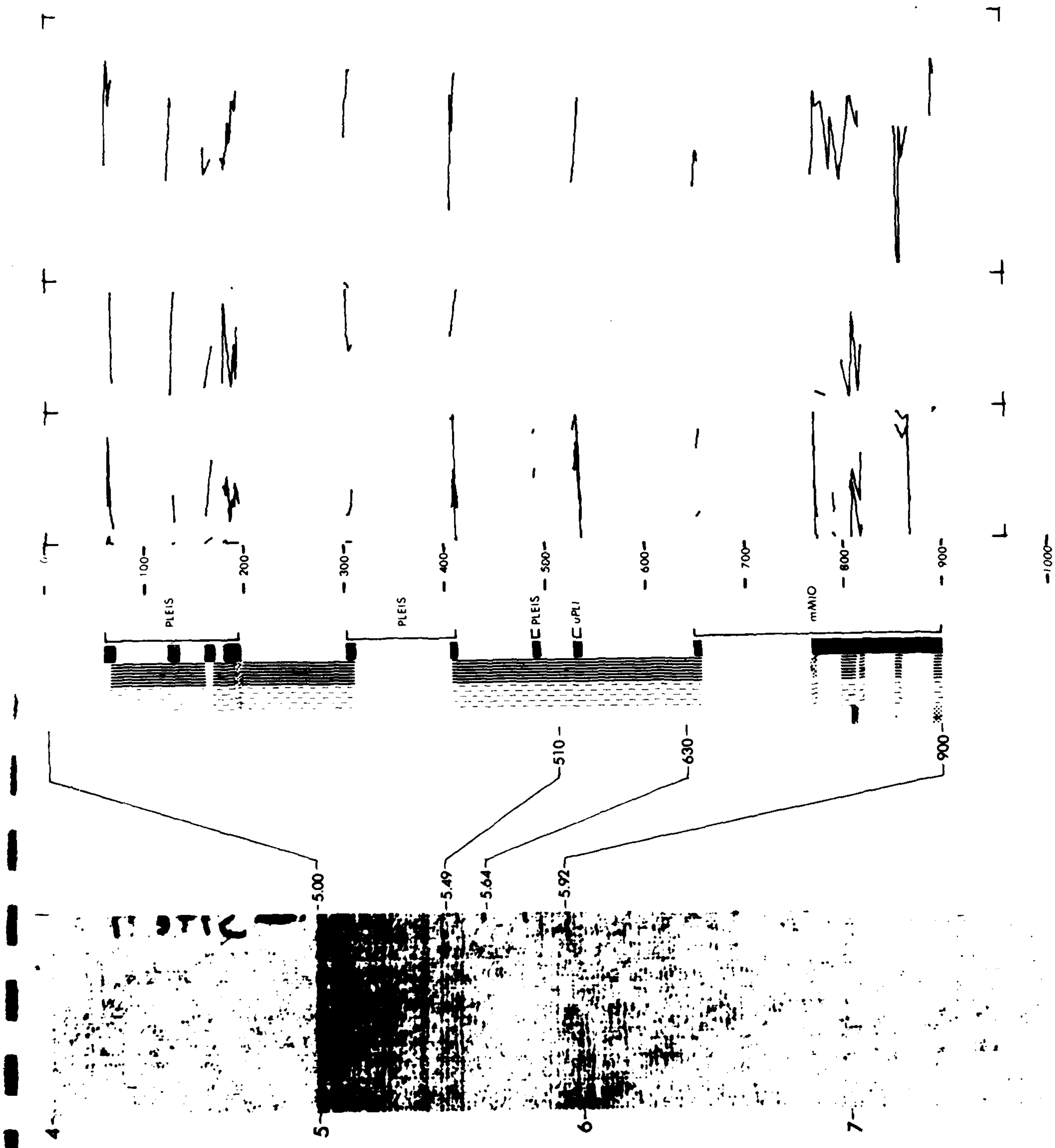
Penetration:		
Drilled--	686	meters
Cored----	214	meters
Total----	900	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	25	cores
	148	meters

Several discontinuities within the Plio-Pleistocene section appear to offer support for interpretation of multiple sources and were initially suggestive of such a relationship. The material above approximately 180 meters appears to have been largely derived via the Mississippi Fan. Sediment below 180 meters to approximately 300 meters may reflect a more important northern/northwestern source. The larger proportion of remaining Upper Pleistocene sediment, from 400 to approximately 460 meters, is evidently of Mississippi Fan derivation. Below this level, most of the graded sands appear to represent a northwestern Gulf source, being characterized by dark gray to gray sands with an immature mineralogical and rock fragment assemblage. This continues to the bottom of the hole (Middle Miocene). The gradual shift in prime sediment source upwards through the section penetrated suggests either shifting depocenters on the northern Gulf clastic-dominated shelf or that the abyssal plain has had a varied bathymetric configuration during upper Cenozoic sedimentation. The sequence of Miocene turbidites, evidently quite thick as judged from the profiler record, indicates a prolonged period of turbidite sedimentation. This appears to argue for eustatic changes of sea level during Middle Miocene time.

Calcareous sediment interbedded with few thin layers of detrital or siliceous, chert fragment rich, sediments.



SITE 91 LEG 10



SITE DATA

Position:
Latitude 25°50.7' N
Longitude 91°49.3' W
Date: 03 16 70
Time: 0500Z
Water depth: 2573 meters
Location: Texas—Louisiana Gulf Coast continental shelf

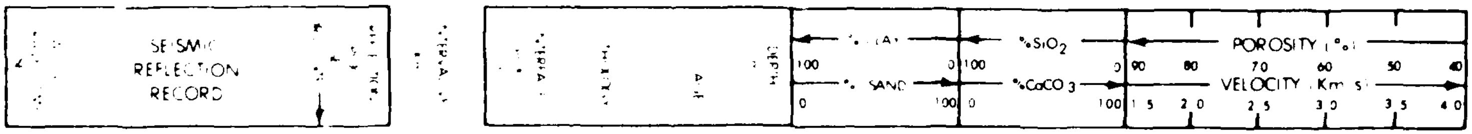
CORE DATA

Penetration:
Drilled-- 212 meters
Cored---- 70 meters
Total---- 282 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 11 cores
41 meters

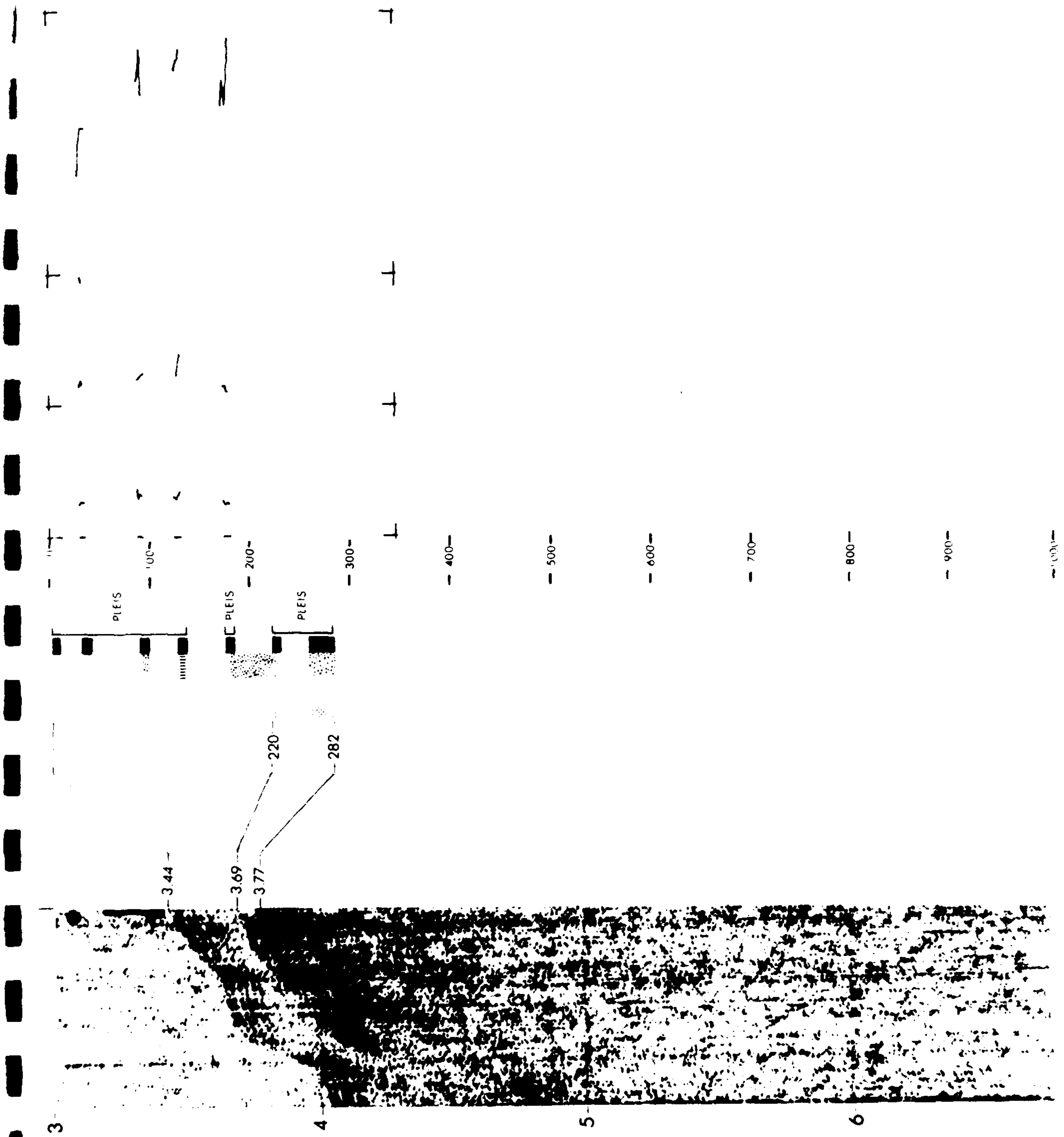
Site 92 represents a less turbidity current-dominated section, i.e., the scarp crest was accumulating sediment less rapidly than the nearby, bathymetrically lower rise area. This suggests that only dilute, low energy "tails" were able to accumulate on the scarp. The Lower Pleistocene section in Site 92 is definitely more pelagic than the Upper Pleistocene, containing significant faunal elements and often moderately burrowed. These sediments undoubtedly accumulated at somewhat reduced rate over those of the Upper Pleistocene. Of special interest is a short segment of sediment core from the base of Core 6, which contains nannofossil ooze. This particular zone (see paleontological report) contains an abundant fauna of reworked older forms. The contemporaneity of the sediment suggests that the older faunal elements represent a local source of reworked, possibly resedimented ooze. The consolidated and deformed state of Early Pleistocene mud/claystones could be considered as evidence of deeper burial than at present. The more pelagic nature of the Lower Pleistocene sediment suggests accumulation on an isolated bathymetric high, although Lower Pleistocene sediment appears to be generally more pelagic where examined on the adjacent abyssal plain.

One thin bed of calcareous sediment, middle Pleistocene age.

92



SITE 92 LEG 10



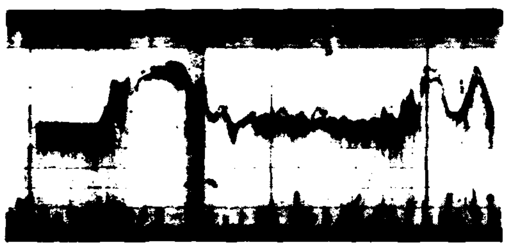
SITE DATA

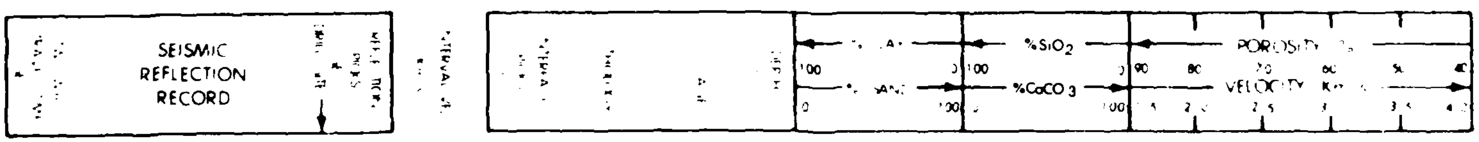
Position:
Latitude 22° 37.2' N
Longitude 91° 28.8' W
Date: 03/21/70
Time: 1500Z
Water depth: 3090 meters
Location: Campeche Scarp

CORE DATA

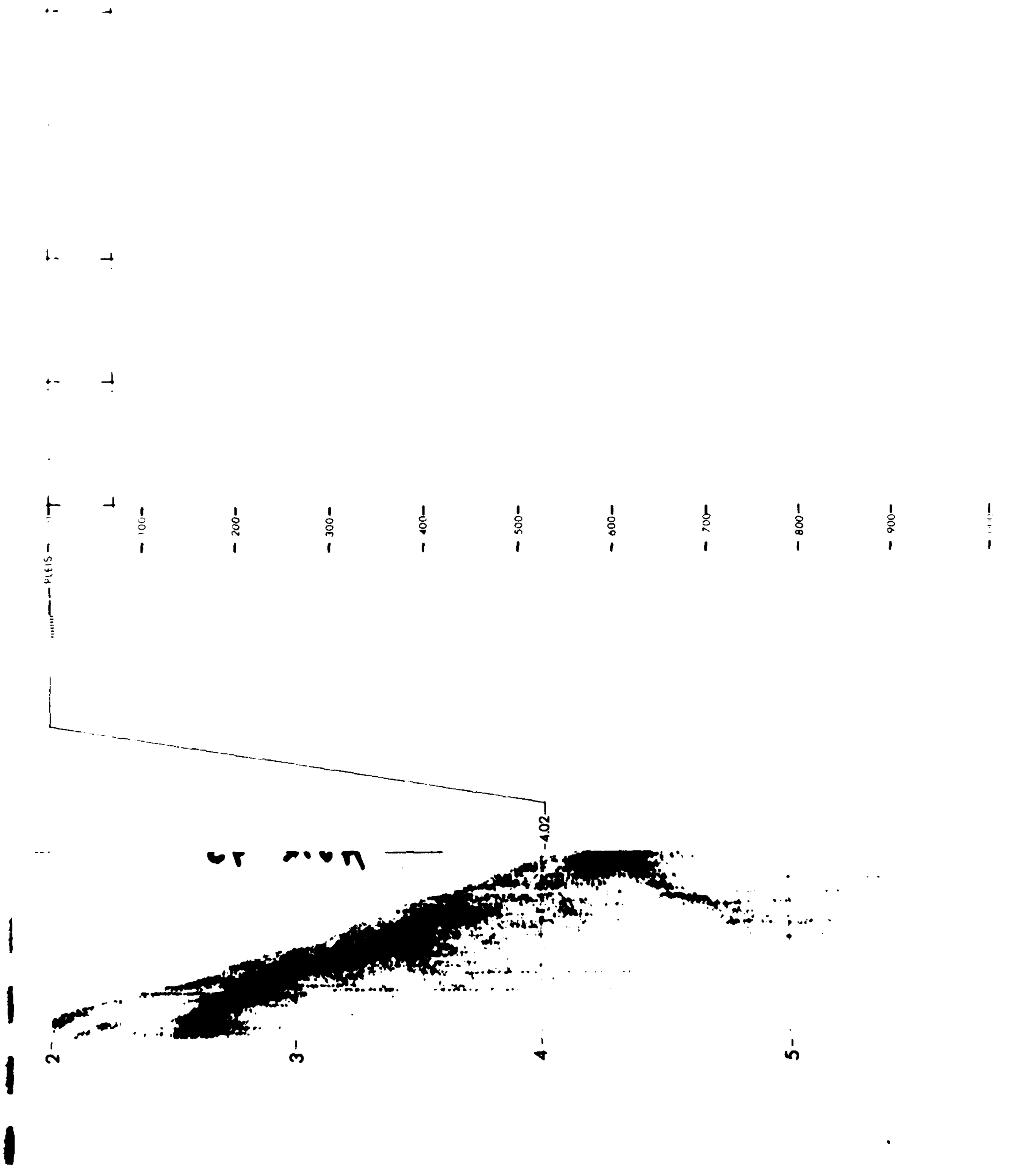
Penetration:
Drilled---- 0 meters
Cored---- 1.5 meters
Total---- 1.5 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 1 cores
1 meters

The presence of reworked sediment of various ages suggests considerable gravity slumping at Site 93. The essentially pelagic composition of sediments suggests this slumping was intermittent and low such that "overconsolidation" of these sediments was somehow facilitated. Evidence as to the origin of the canyon at Site 93 does not appear forthcoming on the basis of this one short core. Within the framework of deposition reflected by the sediments recovered from the site, an interpretation of a bathymetric low or reentrant is all that appears to be required. If the canyon is an erosional feature, then the data in hand would suggest a history of erosion of any age but Late Pleistocene and Holocene. Such a history could conceivably be as old as Cretaceous. Increased clay percentages in sediments at Site 93, in contrast with slope sediments of equivalent age at Sites 86, 94, and 95, suggest that greater depth and proximity to the abyssal plain may be important considerations.





SITE 93 LEG 10



SITE DATA

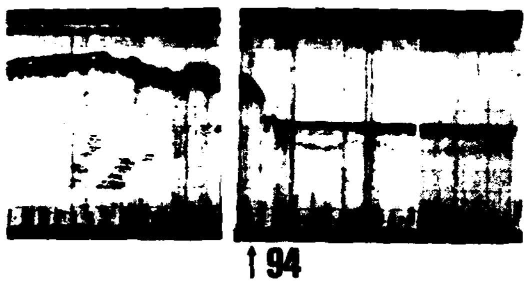
Position:
    Latitude $24^{\circ} 31.6'$ N
    Longitude $88^{\circ} 28.2'$ W
Date: 03/22/70
Time: 1400Z
Water depth: 1793 meters
Location: Campeche Scarp

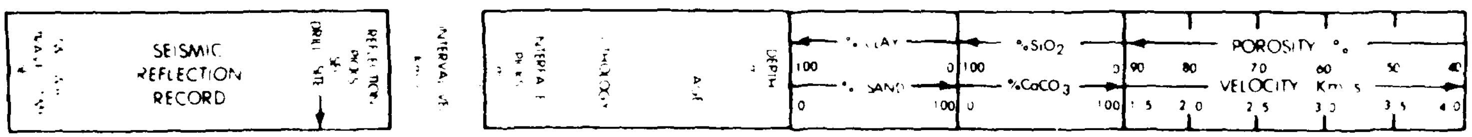
CORE DATA

Penetration:
    Drilled-- 364 meters
    Cored---- 296 meters
    Total---- 660 meters
Recovery:
    Basement- 0 cores
    0 meters
    Total---- 40 cores
    175 meters

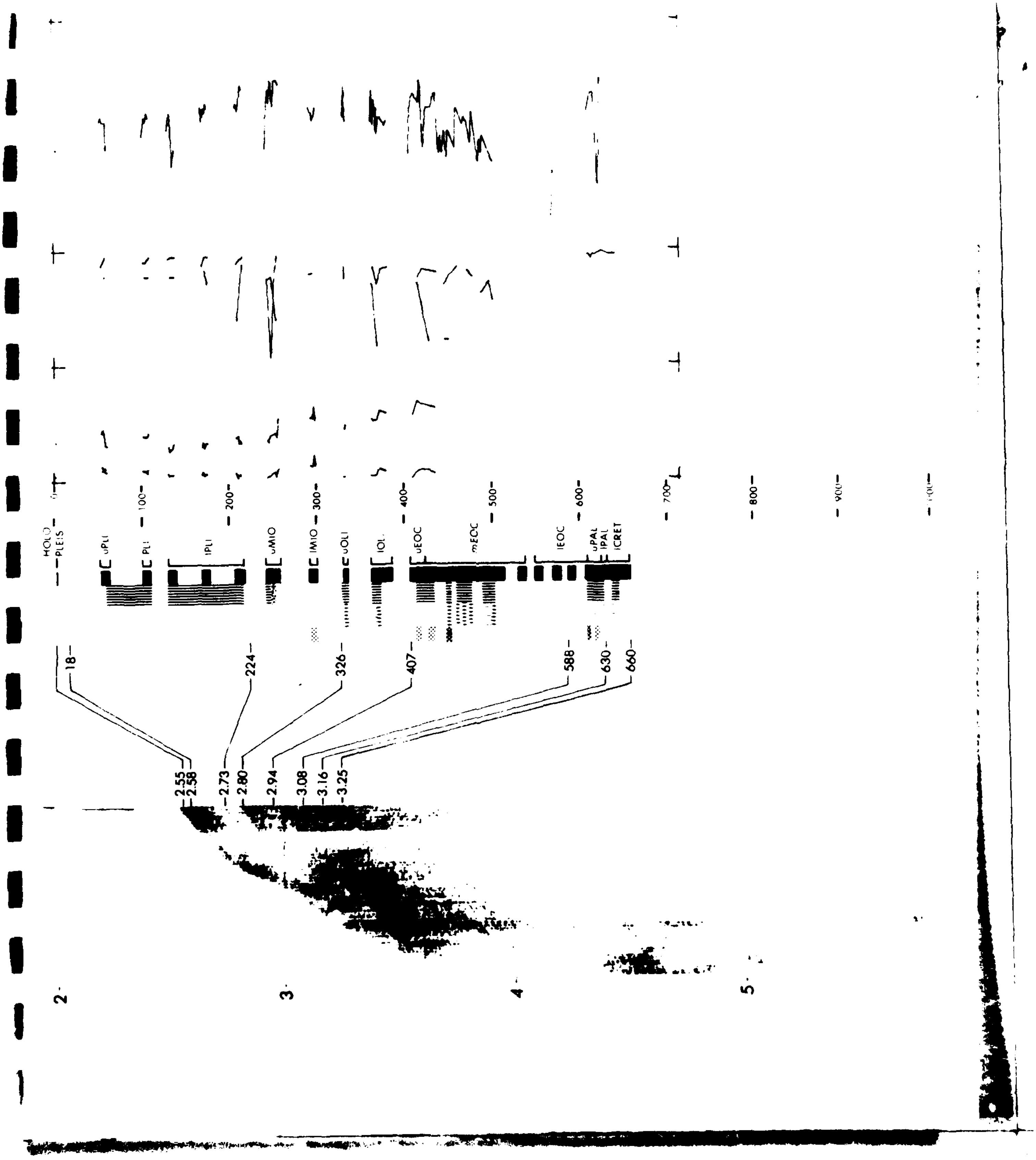
The entire Cenozoic section represented at Site 94 is pelagic in origin. Carbonate marine microorganisms represent dominant constituents throughout. Pelagic sediments are dominant in the lower Teritary also, with the addition of siliceous organisms such as Radiolaria and the lack of terrigenous clay. The presence of chert in Lower Eocene strata is especially interesting, inasmuch as this quite possibly marks the first occurrence of these sediment types in the deep-water Gulf in Eocene beds. The slightly higher argillaceous content of Paleocene strata suggests that the Cretaceous-Tertiary boundary is a lithological substantiation of a major stratigraphic change. The presence of Cretaceous shallow-water carbonates immediately beneath the pelagic oozes of the Paleocene certainly substantiates such a statement. Following deposition of the Cretaceous shallow-water carbonates, a period of nondeposition or erosion followed. Although the extent of the unconformity is unknown, the first sediment type observable above the unconformity is definitely a comparatively deep-water pelagic ooze. There is no strong evidence of significant changes in water depth above that level through to the Recent.

Calcareous sediments sometimes nannofossil rich.





SITE 94 LEG 10



SITE DATA

Position:
- Latitude 24°09.0' N
- Longitude 86°23.8' W

Date: 03/26/70
Time: 2300Z
Water depth: 1633 meters
Location: Campeche Scarp

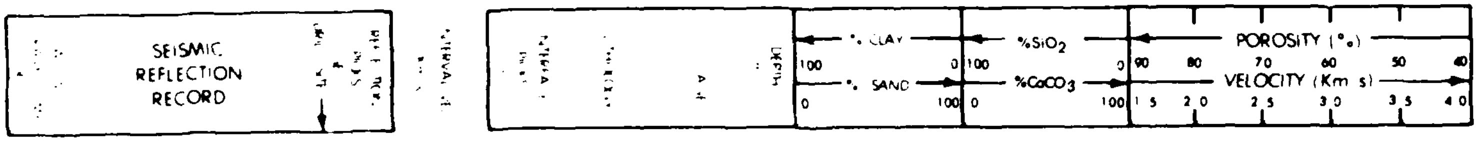
CORE DATA

Penetration:
- Drilled-- 293 meters
- Cored---- 170 meters
- Total---- 463 meters

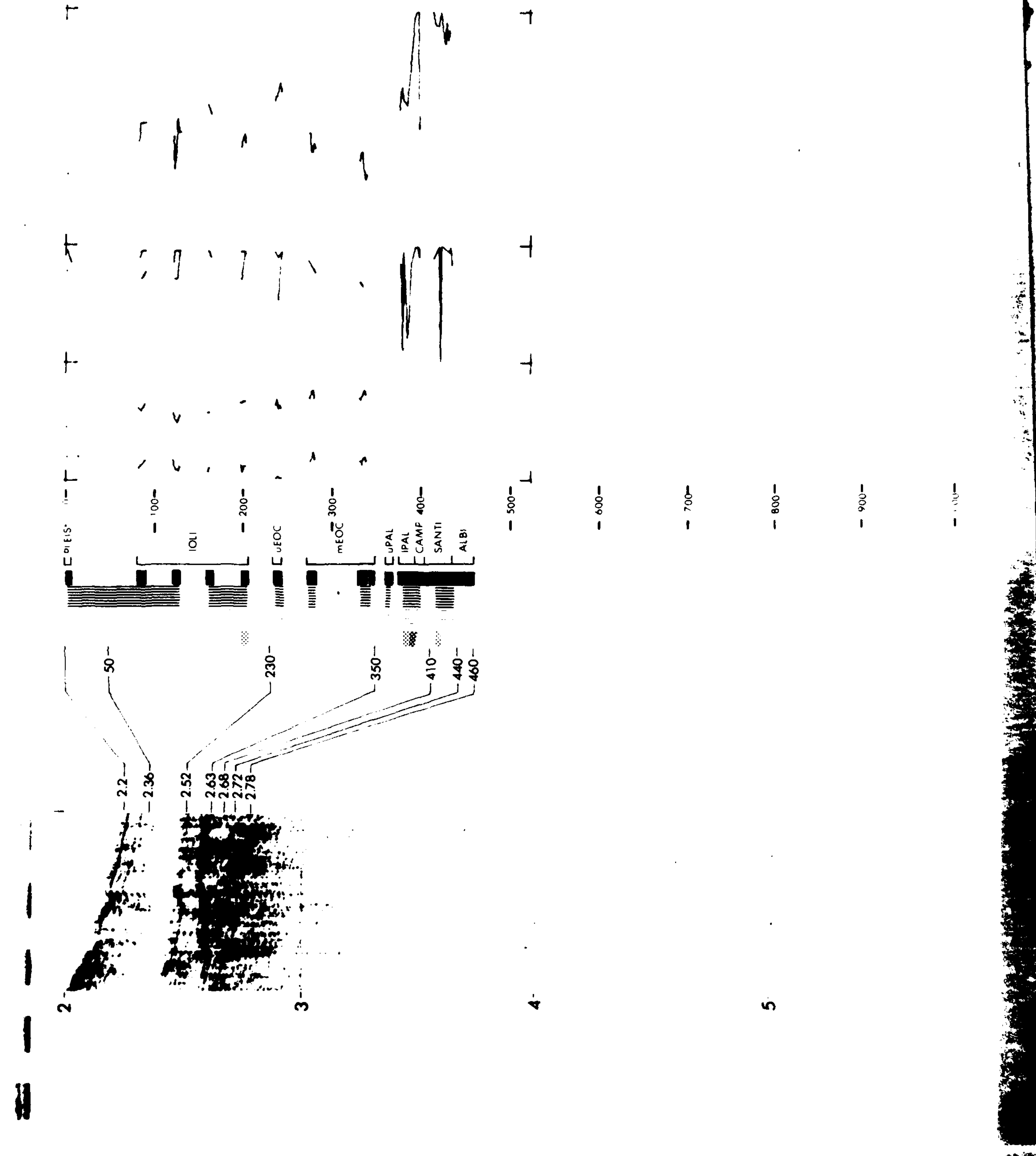
Recovery:
- Basement- 0 cores, 0 meters
- Total---- 22 cores, 118 meters

No indications of significant bathymetric variations were found which supports the interpretation of subsidence of the Yucatan platform during post-Albian, pre-Santonian time. The various unconformities represented in the rock record since that time are probably of complex origin, some representing major regional disconformities whereas others are totally local. The authors favor gravity slumping as a probable interpretation for most of the missing section. It is interesting to note that in the shallow-water Lower Cretaceous limestones and dolomites from the three holes, no evidence of reef-building organisms has been noted. On the basis of sedimentological parameters, carbonate petrography, and paleontological interpretations, the consensus appears to be shallow-shelf to supratidal environments for the upper few tens of meters of Lower Cretaceous platform carbonates penetrated at Sites 86, 94, and 95. Pusey (personal communication) states that these miliolid-rich mudstones and wackestones are identical with restricted, shallow-shelf deposits known from other portions of the Gulf of Mexico. Following deposition of these shallow-water carbonates, the ensuing transgressive phase of sedimentation was not accompanied by reef development or such sediments were subsequently removed by erosion.

Calcareous sediments occasionally nannofossil rich.



SITE 95 LEG 10



SITE DATA

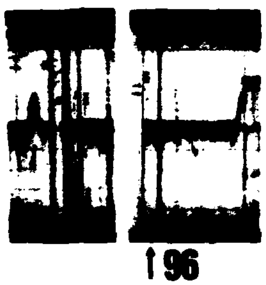
Position:
Latitude 23°44.6' N
Longitude 85°45.8' W
Date: 03/30/70
Time: 0725Z
Water depth: 3439 meters
Location: Knoll in the Catoche Tongue area

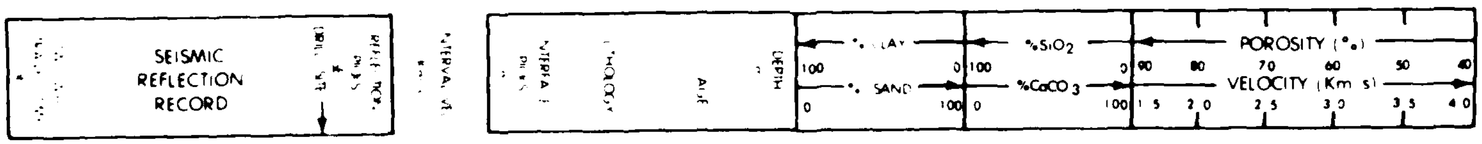
CORE DATA

Penetration:
Drilled-- 293 meters
Cored---- 39 meters
Total---- 332 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 5 cores
28 meters

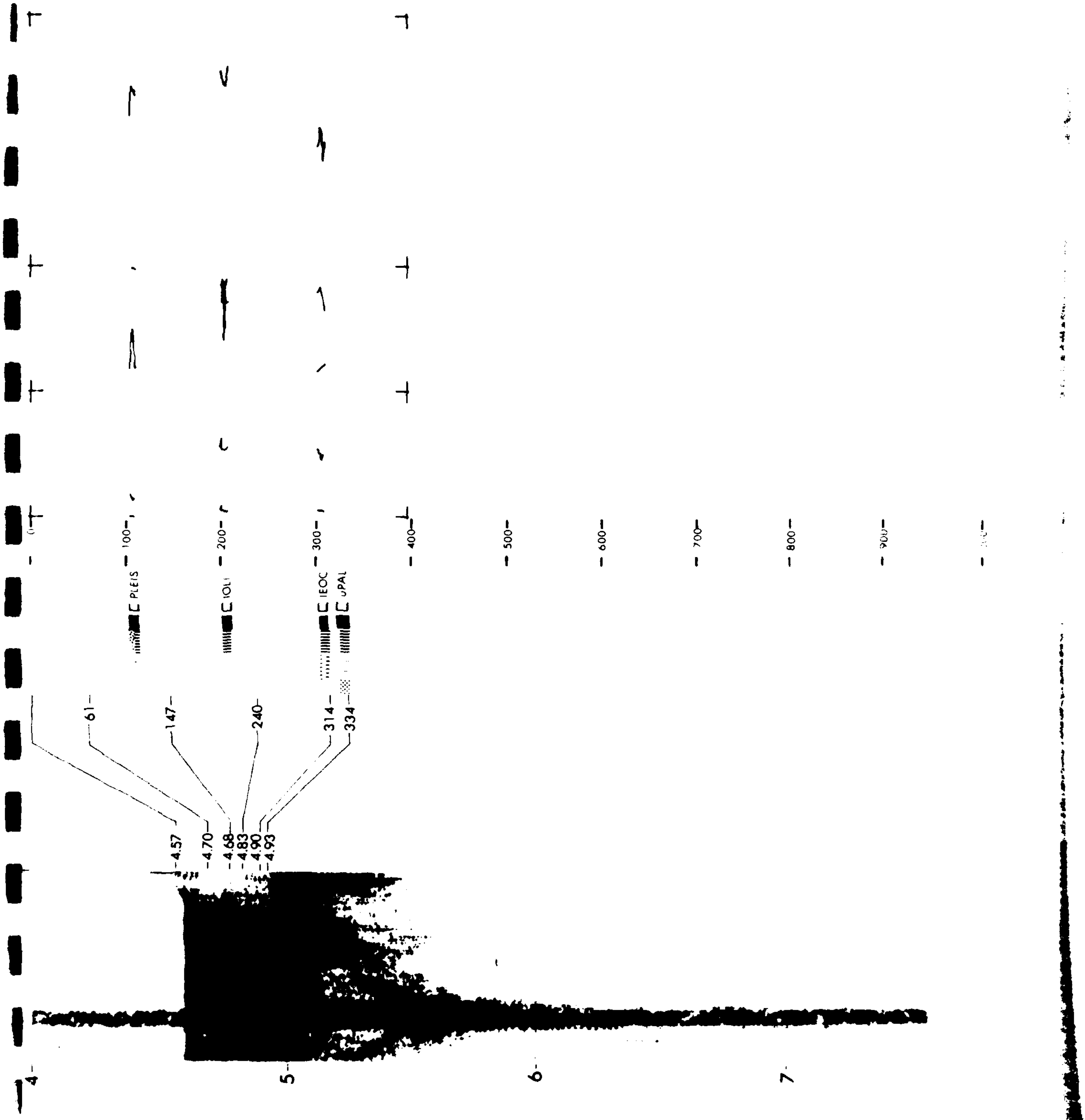
The presence of lower Tertiary pelagic oozes at Site 96 suggests considerable relief on the surrounding sea floor such that normal abyssal plain sediments could not be deposited on bathymetric highs. As terrigenous abyssal plain sedimentation continued to the north, it might be postulated that subsidence of the area eventually brought the crest of the knoll within reach of turbidity current sedimentation. The rather thick abyssal fan to the north and interpreted stratigraphic relationships within the fan suggest that accelerated burial subsidence probably took place during Pleistocene time. Alternatively, the relationships described above could be interpreted as an indication of eventual "filling" of the southeastern "end" of the abyssal plain, some knolls being buried during earlier stages of sedimentation. Other knolls of greater relief still stand well above the level of the abyssal plain and are thus without a Pleistocene abyssal plain cover. Core 1 is interpreted as representative of Mississippi abyssal plain sedimentation. Core 2 (Early Oligocene) contains the youngest stratigraphic occurrence of chert yet noted from the various holes drilled on Leg 10.

Calcareous sediments occasionally nannofossil rich.





SITE 96 LEG 10



SITE DATA

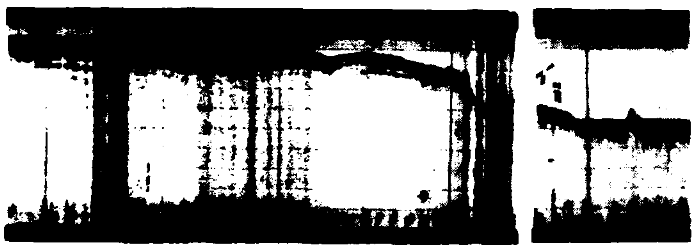
Position:
Latitude 23°53.0' N
Longitude 84°26.7' W
Date: 03/31/70
Time: 0725Z
Water depth: 2930 meters
Location: Between the Florida Platform and the Campeche Bank

CORE DATA

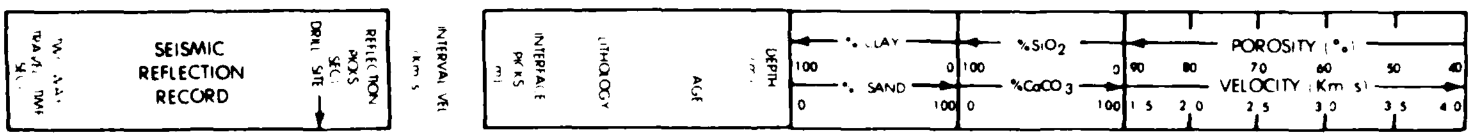
Penetration:
Drilled-- 278 meters
Cored---- 59 meters
Total---- 337 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 12 cores
35 meters

Perhaps the most interesting sedimentological aspect of Site 97 is the occurrence of pebbly mudstone and associated deep-water sediments, primarily nannofossil-rich calcilutite. The general occurrence of exotic clasts suspended in a matrix of mixed, deep-water ooze/clay and "shallow-water" debris of variable size is common to deep-water sediments of many areas. The rather unique textural mix and fabric of pebbly mudstones has been generally ascribed to a gravity-dominated process known as low velocity mass flow or simply as gravity mud slides of submarine origin. The association of these sediments with calcilutite containing a deep-water fauna is suggestive of nearby areas of high bathymetric relief. The writers would like to suggest that mid-Cretaceous time was marked by a general period of (eustatic?) emergence in the Gulf Coast basin. In the southeastern Gulf of Mexico area, the advent of pebbly mudstone deposition may reflect a basic period of emergence, whether eustatic or not, during which the incidence of shelf edge-slope gravity slumping would be increased. The hard, dense, horizontally to vaguely laminated to sparsely mottled calcisiltite and calcilutite which occur in Cores 11 and 12 are of somewhat uncertain origin.

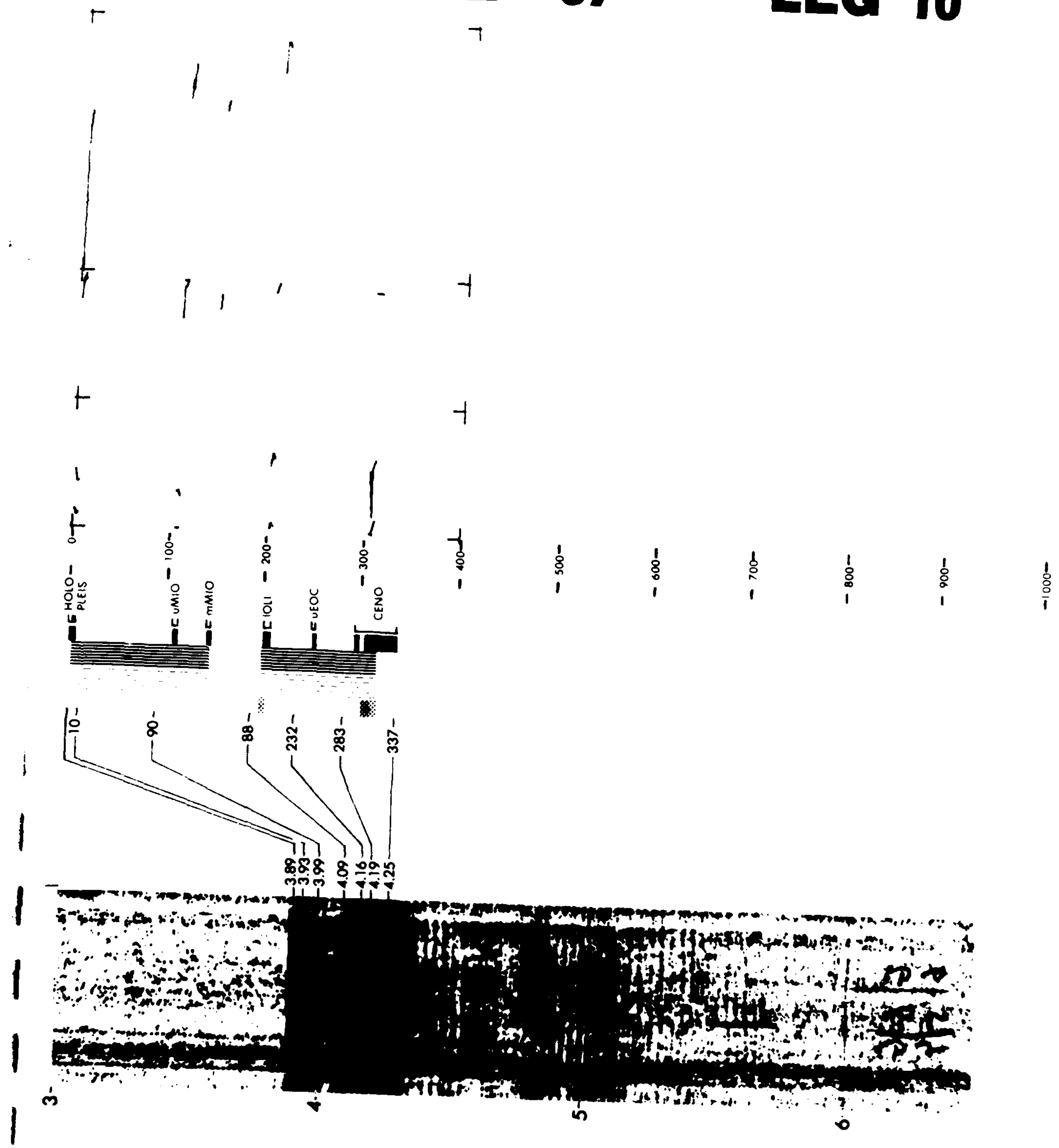
Pleistocene and Miocene sediments nannofossil rich.



97



SITE 97 LEG 10



SITE DATA

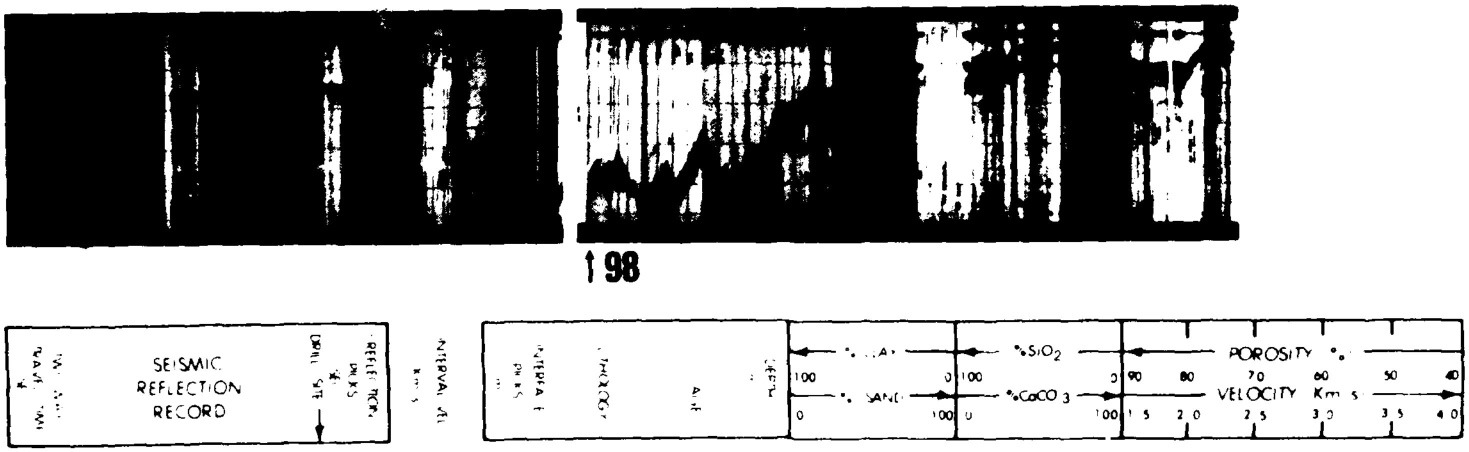
Position:
Latitude 25°22.9' N
Longitude 77°18.7' W
Date: 04/09/70
Time: 0850Z
Water depth: 2769 meters
Location: Northeast Providence Channel

CORE DATA

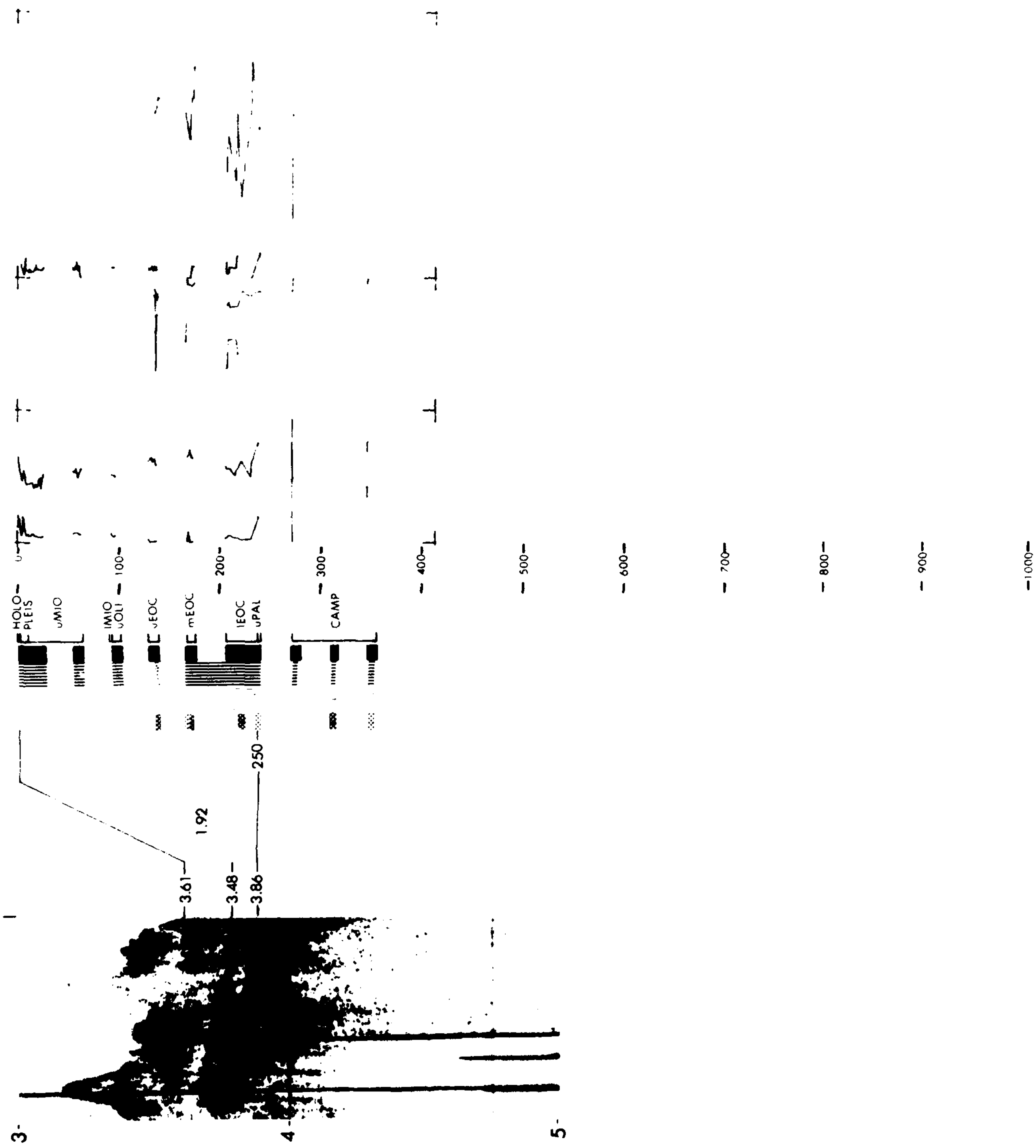
Penetration:
Drilled-- 235 meters
Cored---- 122 meters
Total---- 357 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 15 cores
80 meters

The predominance of comparatively well-preserved calcareous foraminifera and nannoplankton suggests that deposition in the Northeast Providence Channel during Tertiary and late Cretaceous times occurred in a deep-water environment and above the calcium carbonate compensation depth. The absence of inorganic debris, spores and pollen suggests a lack of terrigenous sediment contribution. Volcanic glass and zeolites found in the Miocene, early Eocene and Paleocene sediments may be related to volcanism in Cuba. The presence of shallow-water benthonic foraminifera and peri-reef limestone indicate displacement of coarse material into the deep channel during late Cretaceous time. Most lower Tertiary and upper Cretaceous foraminiferal-nannoplankton ooze has been recrystallized. Sediments from Site 98 and data from wells drilled on Andros and New Providence Islands suggest that the Northeast Providence Channel has been built by the upward growth of reef walls on a subsiding Bahama platform and it has been the site of deep-water deposition of pelagic carbonate oozes since at least late Cretaceous time.

Sediments, calcareous and nannofossil rich.



SITE 98 LEG 11



SITE DATA

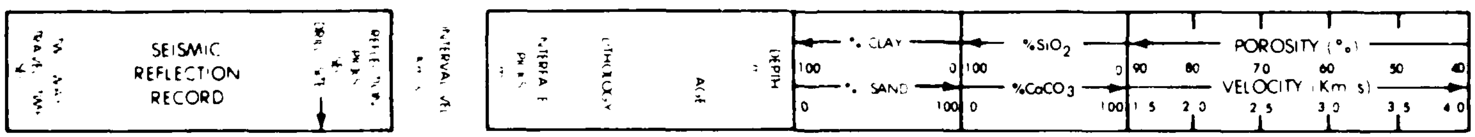
Position:
Latitude $23^{\circ} 41.1'$ N
Longitude $73^{\circ} 51.0'$ W
Date: 04/13/70
Time: 1347Z
Water depth: 4914 meters
Location: Cat Gap

CORE DATA

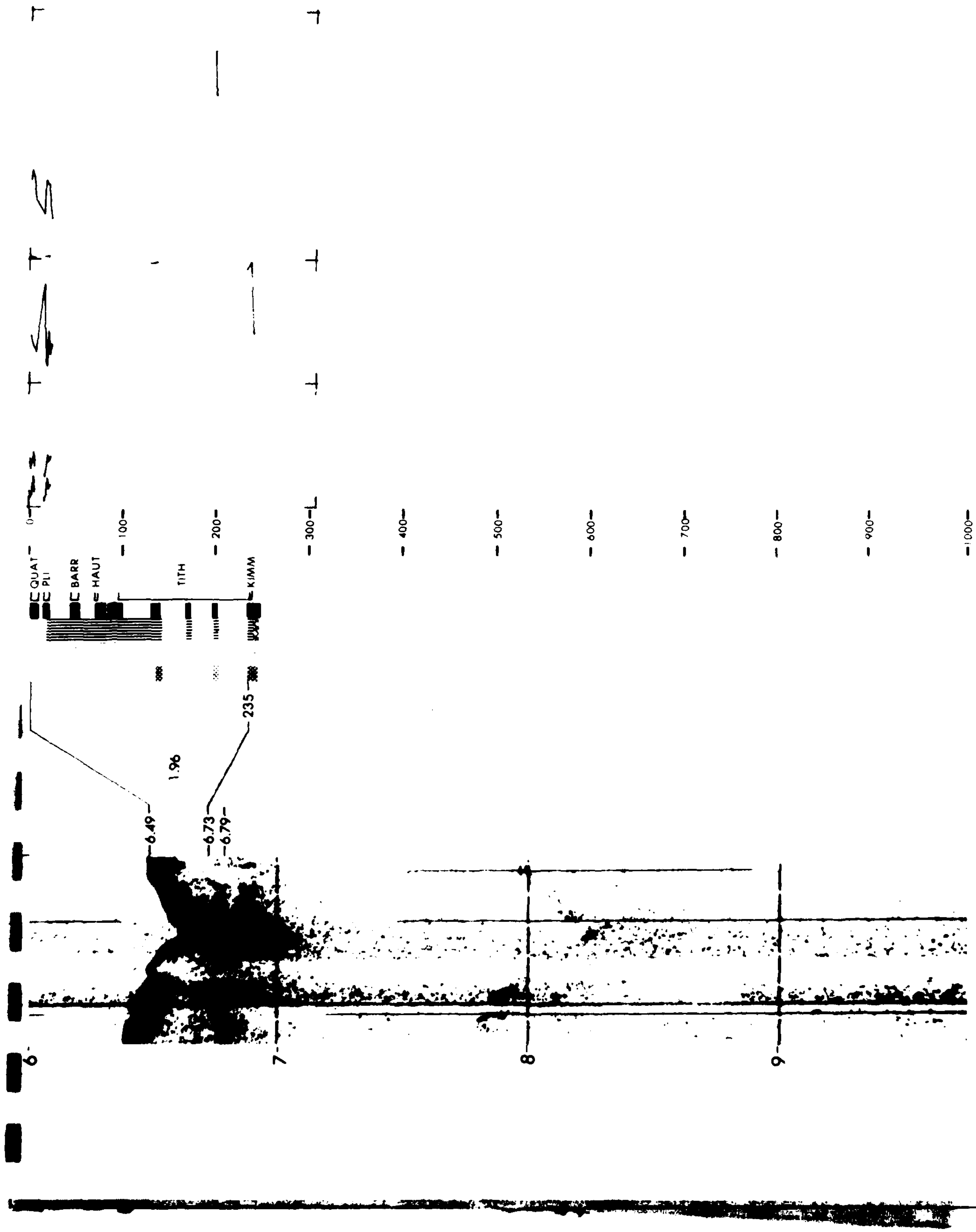
Penetration:	99	99A	
Drilled--	84	152	meters
Cored----	0	96	meters
Total----	84	248	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	0	14	cores
	0	29	meters

The relative abundance of terrigenous components suggests a source other than the Bahama platform, which is relatively close. They might have been transported into the area from the north. There is evidence of bottom water stagnation in the Oxfordian sediments. The early Cretaceous sediments at Site 99 are principally cherty oozes, chalk, and shallow, warm-water carbonate debris, suggesting "normal" pelagic deposition above the carbonate compensation depth, with periodic inflowing of fore-reef material from the nearby Bahama platform. The hiatus cannot be definitely established because of the unsampled interval between these two cores. During the Pleistocene, terrigenous material was again deposited in the area and probably transported not more than 200 to 300 miles from the source area. After the last influx of terrigenous material, sediment deposition has been "normal" pelagic and hemipelagic to the present. The pre-Recent deposits are characterized by a thick layer with abundant larger foraminifera. There is a principal change at about 235 meters from marl and chalk to a hard limestone.

Most sediments nannofossil rich.



SITE 99 LEG 11



SITE DATA

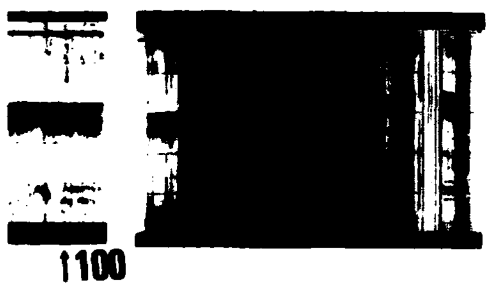
Position:
Latitude 24°41.3' N
Longitude 73°48.0' W
Date: 04/24/70
Time: 1300Z
Water depth: 5325 meters
Location: Cat Gap

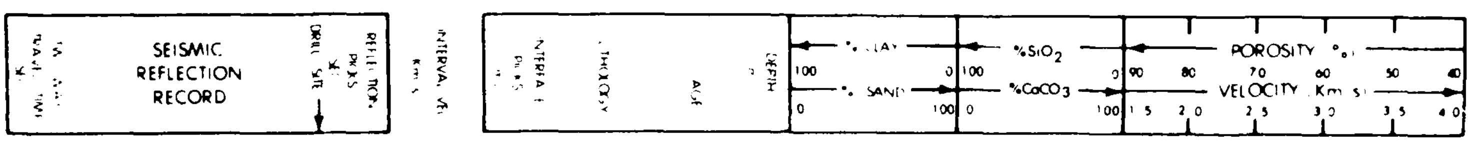
CORE DATA

Penetration:
Drilled-- 238 meters
Cored---- 93 meters
Total---- 331 meters
Recovery:
Basement- 4 cores
4.5 meters
Total---- 13 cores
30 meters

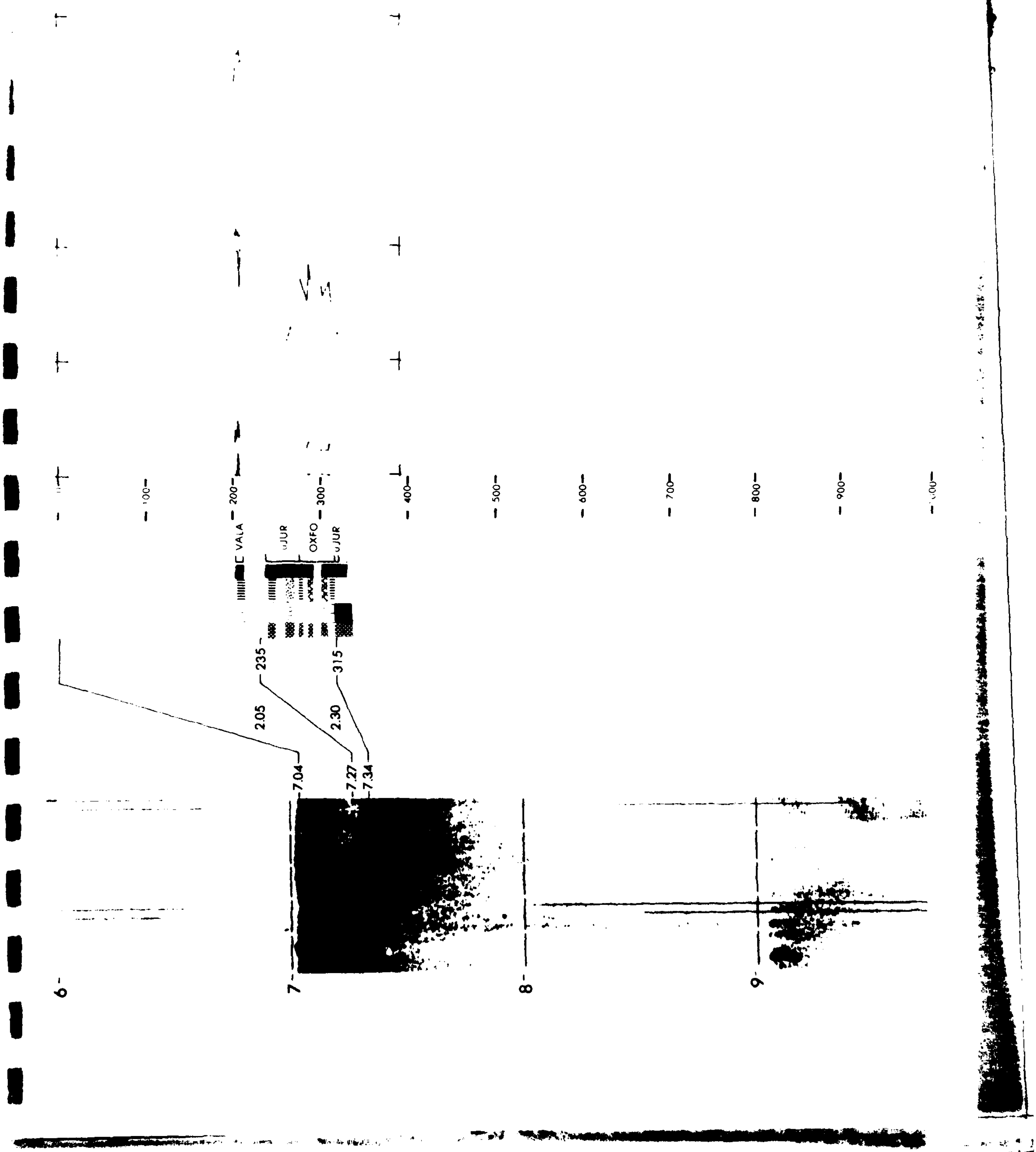
The basaltic rock could have been produced either by a Jurassic basalt flow or by a sill in the Jurassic sediments. From the ratio of apparent penetration to basalt recovered (about 14:4), we judged at the time that there was a good possibility that the drill had penetrated two or three soft layers interbedded with the basalt, even though there was nothing in the recovered samples to indicate this. The basalt contains inclusions of limestone with the same nannofossils as the immediately overlying sediments. There are 40 meters of greenish-gray argillaceous limestone immediately above the basalt. The foraminiferal and ostracod faunas indicate a trend to shallowing towards the base of the section, although water depth was probably never shallower than bathyal. The approximately 50 meters of late Jurassic reddish limestone and calcareous mudstone contain numerous flow structures and clasts which indicate deposition in an active environment. The nannoplankton ooze of Valanginian to Tithonian age can be attributed to a deep-bathyal environment. The nature of the sediments and the microfaunas provides evidence for a gradually deepening depositional environment from middle (?) Jurassic to early Cretaceous time.

Sediments mostly nannofossil rich.





SITE 100 LEG 11



SITE DATA

Position:
- Latitude 25°11.9'N
- Longitude 74°26.3'W

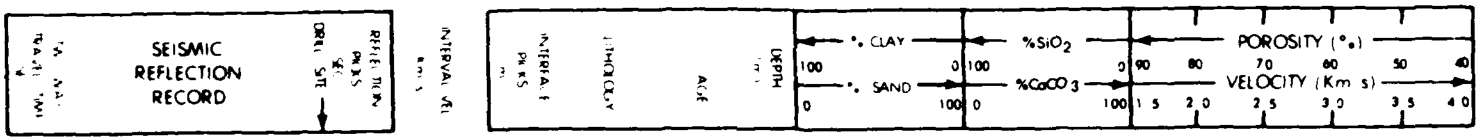
Date: 04/24/70
Time: 2310Z
Water depth: 4868 meters
Location: Southern Blake-Bahama Outer Ridge

CORE DATA

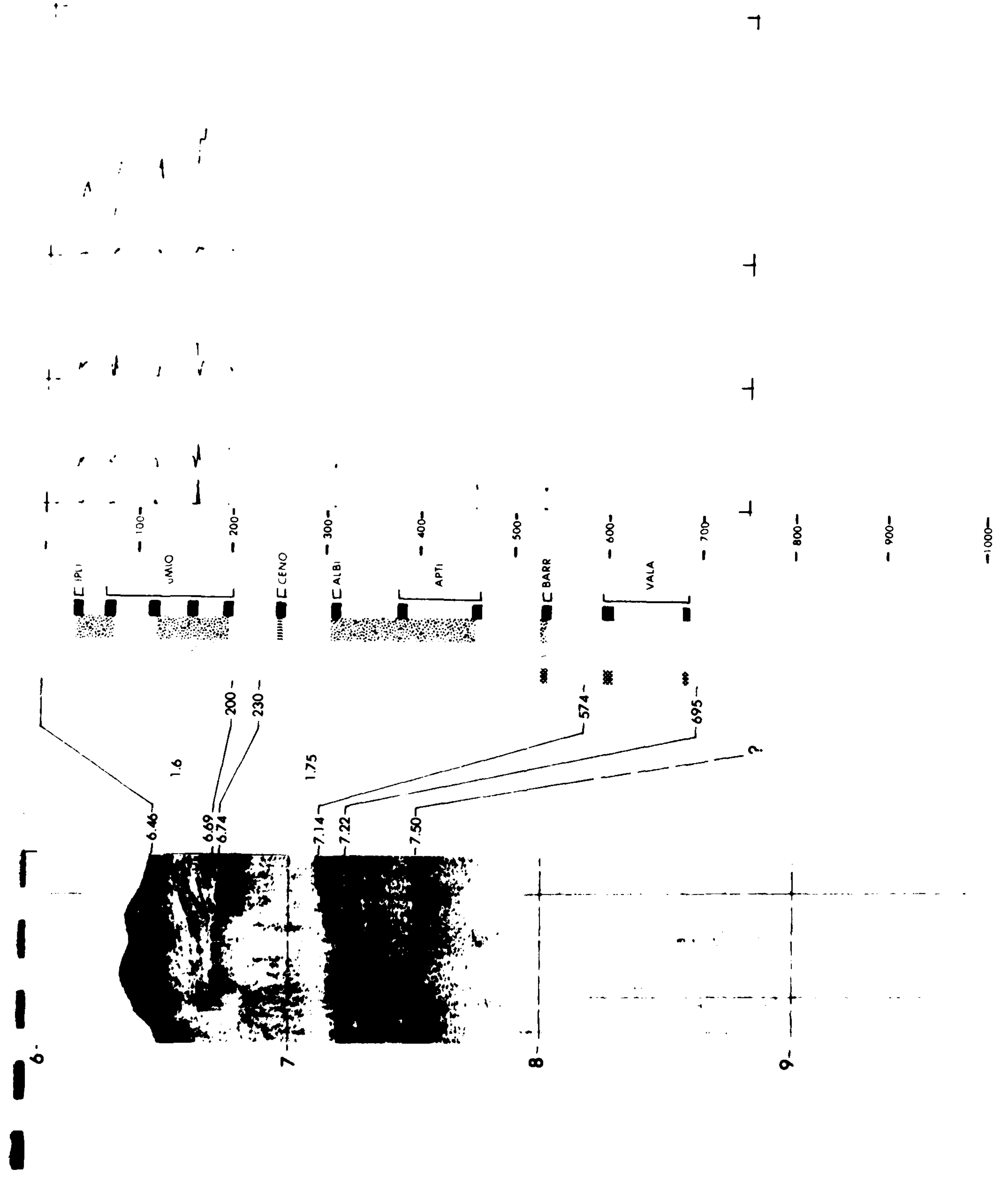
	101	101A	
Penetration:			
Drilled--	58	602	meters
Cored----	18	89	meters
Total----	76	691	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	2	10	cores
	16	23	meters

The early Neocomian carbonate sediments are the cnly layers which are almost purely pelagic in origin. Bedding planes in the gray-white limestone show minor slump and flow structures, current bedding, and bioturbations. The occurrence of abundant organic matter and dark-colored fine laminations undisturbed by benthonic organisms suggests that anaerobic, tranquil conditions occurred periodically during the early Cretaceous. The preservation of the extremely abundant organic matter in Cores 6 through 8 indicates that sea floor stagnation was prevalent during late Neocomian time. The black Neocomian clays may indicate that the black, organic-rich and iron oxide-rich sediments were deposited beneath an open marine environment. The depositional environment at Site 101 was apparently tranquil in early Cretaceous time and at least into the Cenomanian. The hiatus (or extremely shortened section) between early Cenomanian and middle Miocene represents either a long period when bottom currents were strong enough to prevent deposition or a shorter, post-early Cenomanian, period of erosion. Furthermore, the ridge-like shape of the surface of the early Cretaceous accumulation may be a result of early Tertiary-late Cretaceous erosion.

↑101



SITE 101 LEG 11



SITE DATA

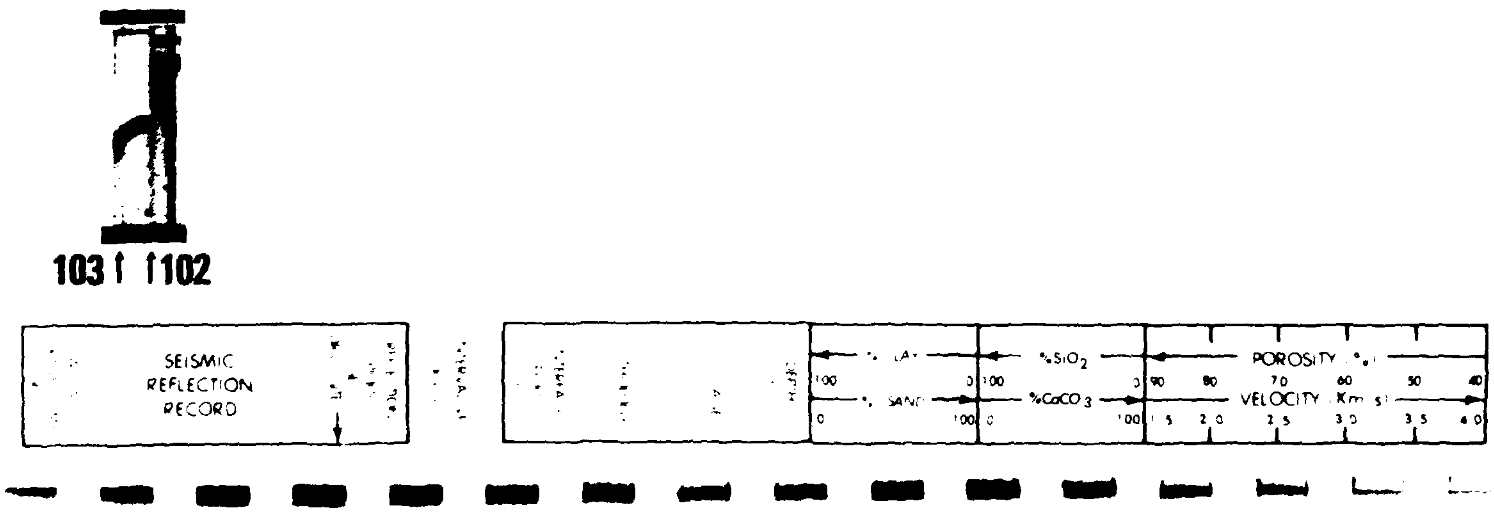
Position:
Latitude 30° 43.9' N
Longitude 74° 27.1' W
Date: 05/04/70
Time: 2338Z
Water depth: 3426 meters
Location: Northern Blake-Bahama Outer Ridge

CORE DATA

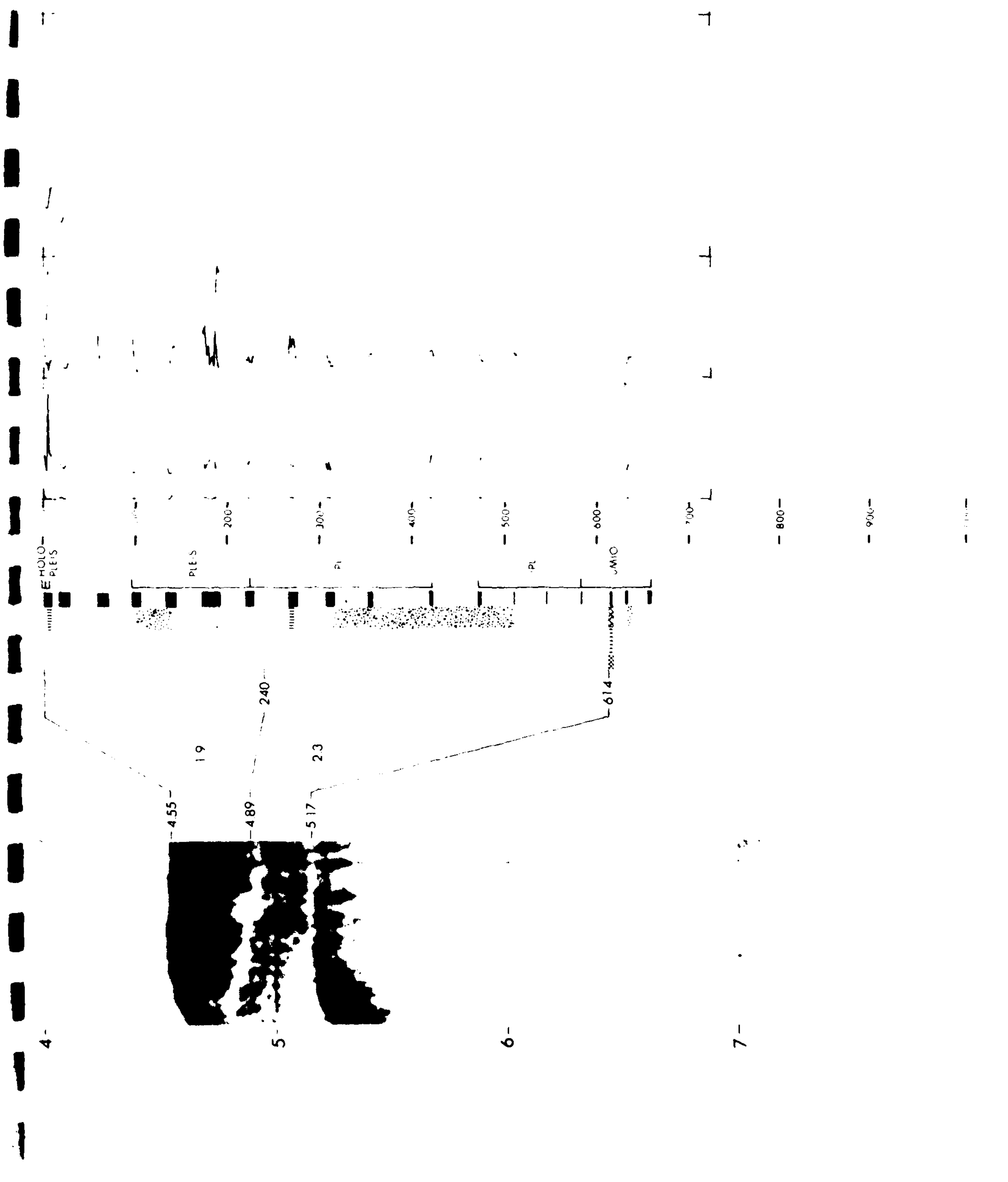
Penetration:
Drilled-- 393 meters
Cored---- 268 meters
Total---- 661 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 17 cores
99 meters

Cores recovered from Sites 102, 103, and 104 can be correlated on the basis of one common biostratigraphic zone (N.17) as well as on the basis of similar sediment composition. Zone N. 16 is present in Holes 102 and 103. The nature of the sediments and the attitude of reflectors recorded on seismic reflection profiles (Markl et al., 1970) suggest that at least the upper 600 meters of the northern end of the Blake-Bahama Outer Ridge is a large accumulation of rapidly-deposited, hemipelagic, silty carbonaceous clay of Pliocene-Pleistocene age that has been transported to this region from the north by southerly-flowing bottom currents. Erosion has occurred along both flanks of the ridge. The underlying 600 meters of late and middle Miocene hemipelagic sediment recovered at Site 104 appear to have been derived from nearer sources. The upper 150 meters of sediment recovered at Site 102 appears to have been deposited as a conformable lens of Pleistocene hemipelagic silty clay on top of the Pliocene and middle Miocene accumulations.

One thin layer of upper Pliocene age, calcareous nannofossil rich.



SITE 102 LEG 11



SITE DATA

Position:
Latitude 30°27.1' N
Longitude 74°35.0' W
Date: 05/05/70
Time: 0130Z
Water depth: 3964 meters
Location: Northern Blake-Bahama Outer Ridge

CORE DATA

Penetration:
Drilled-- 387 meters
Cored---- 62 meters
Total---- 449 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 7 cores
37 meters

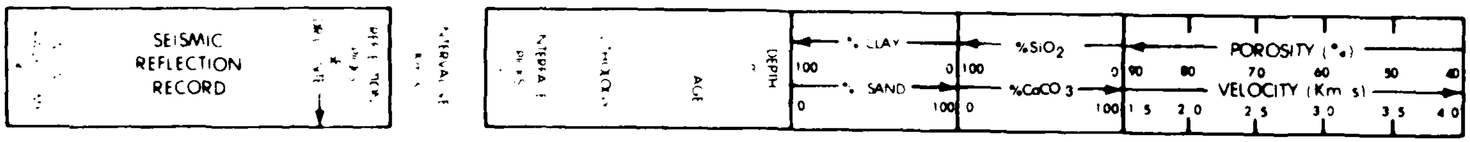
Three main variations in the hemipelagic sediments at sites 102, 103, and 104 are distinguished:

(1) Siliceous, calcareous, and heavy mineral-rich Pleistocene sediments, The upper half meter is Holocene yellow-brown and gray, laminated, silty, foraminiferal ooze. Below the first few meters, the color becomes dark gray to grayish-brown; black patches of iron sulfide become quite abundant.

(2) Pliocene-Late Miocene sediment, homogenous, dark greenish-gray, silty hemi-pelagic mud, occasionally mottled with lighter olive-gray hues.

(3) Middle Miocene sediment . A change at the late-middle Miocene boundary is a gradual decrease in abundance of heavy minerals. Foraminiferal tests and nannoplankton are almost totally lacking in smear slides. At the bottom of the oldest sediment recovered a bed or nodule of ankerite was cored.

Holocene, calcareous sediment foraminifera rich.



SITE 103 LEG 11

SITE DATA

Position:
- Latitude $30^{\circ}49.6'$ N
- Longitude $74^{\circ}19.6'$ W

Date: 05/09/70
Time: 1700Z
Water depth: 3811 meters
Location: Northern Blake-Bahama Outer Ridge

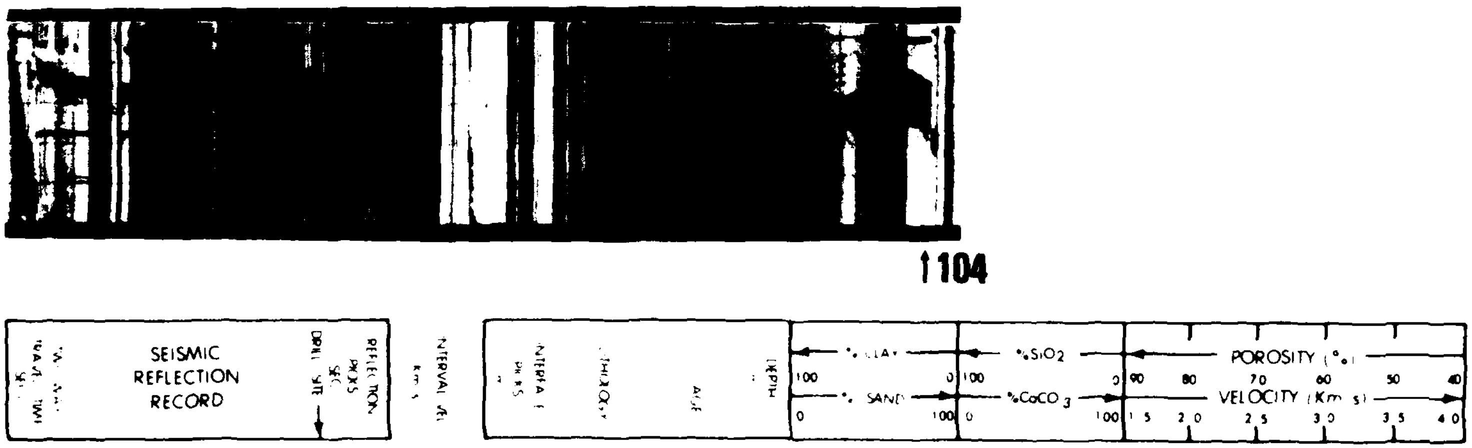
CORE DATA

Penetration:
- Drilled-- 534 meters
- Cored---- 83 meters
- Total---- 617 meters

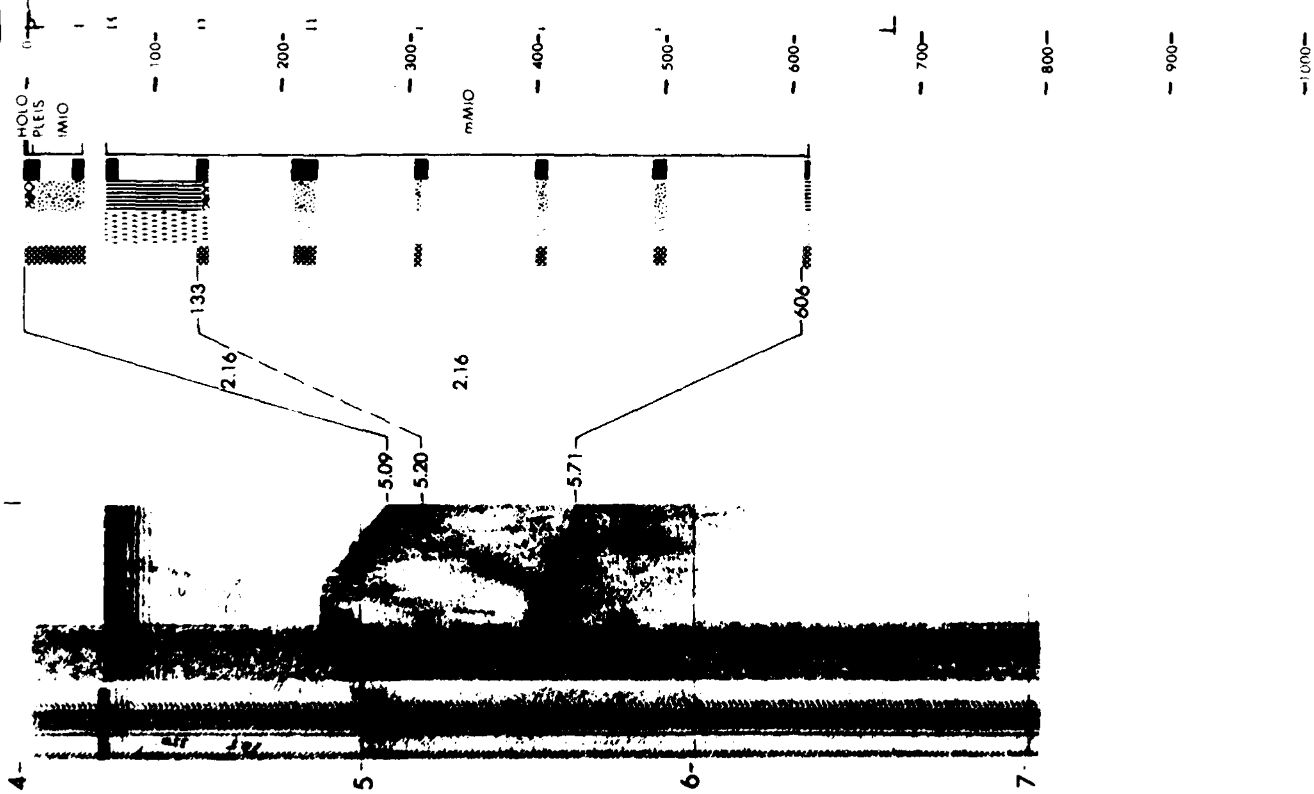
Recovery:
- Basement- 0 cores, 0 meters
- Total---- 10 cores, 56 meters

Discussion on Sites 102, 103, and 104 are together.

Pleistocene, calcareous sediment, authigenic carbonate rich. Top of middle Miocene, thin layer of detrital sediment, estimated carbonate rich.



SITE 104 LEG 11



SITE DATA

Position:
Latitude $34^{\circ}53.7'$ N
Longitude $69^{\circ}10.4'$ W
Date: 05/13/70
Time: 0807Z
Water depth: 5251 meters
Location: Lower Continental Rise Hills

CORE DATA

Penetration:		
Drilled--	292	meters
Cored----	341	meters
Total----	633	meters
Recovery:		
Basement-	4	cores
	9	meters
Total----	43	cores
	197	meters

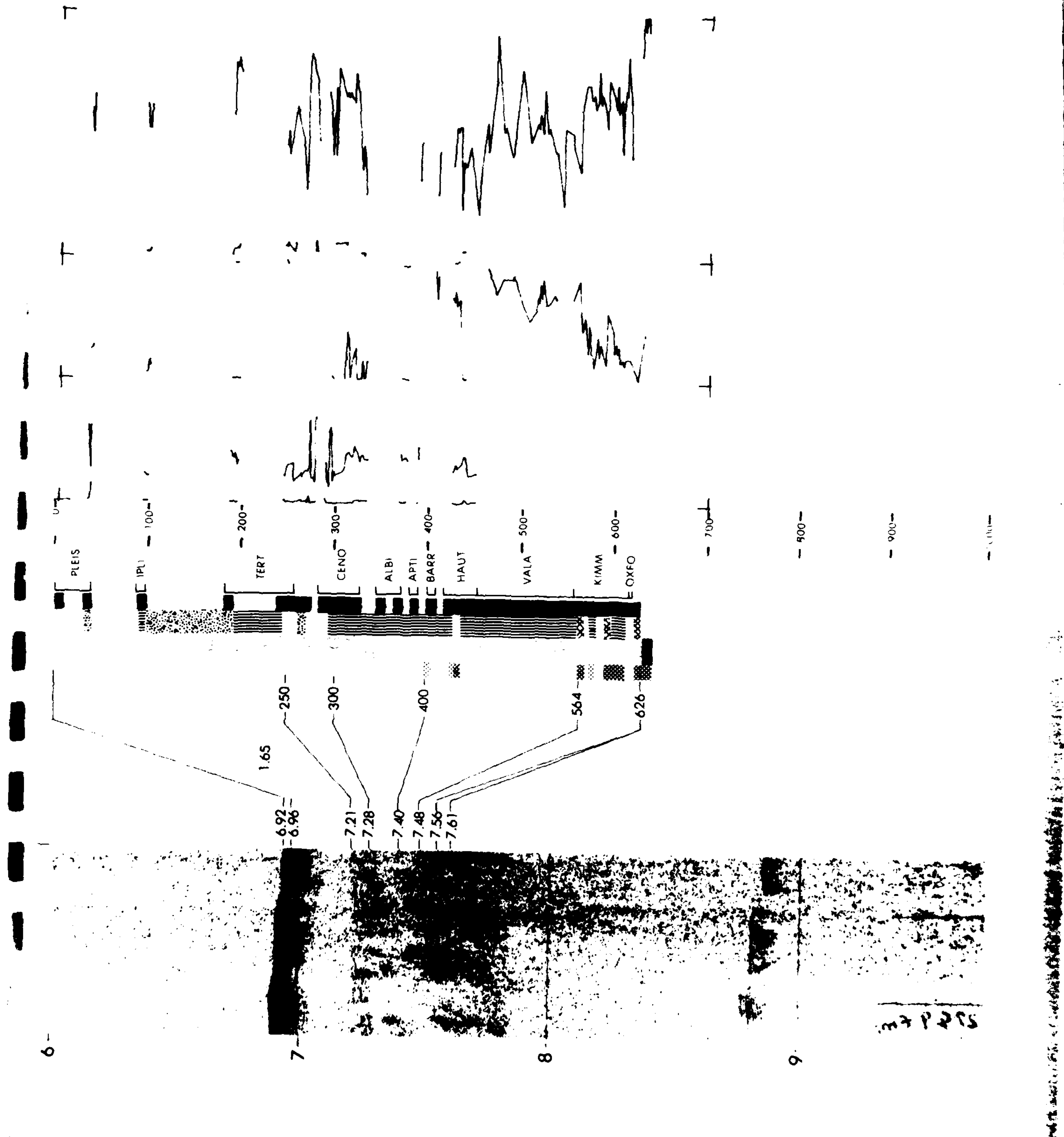
Sedimentation probably began with the accumulation of thin deposits of calcareous nannoplankton ooze on basaltic basement rocks that consist of a series of thin flows and pyroclastic debris. The abundant glassy zones in the basalt suggest pillow lava structure. A late stage sequence of eruptions of volcanic ash consisting of highly differentiated material was the probable source of brightly-colored pyroclastic beds overlying limestone, which is in contact with basalt. The thick sequence of late Jurrasic red, clayey limestones contains occasional fragments palagonite indicating that volcanic activity continued at a greatly reduced rate or at a considerable distance from the area. The sediments of Aprian/Barremain to Cenomanian age represent a period of apparent stagnation in which large amounts of carbonaceous material became incorporated in the sediments. The multicolored zone, overlying the black Cretaceous zone, probably also resulted from the introduction of large amounts of volcanic material, in the form of ash falls, and possibly also from the precipitation of iron and manganese oxides from hydrothermal emanations. The topmost sediments of Hole 105 are typical hemipelagic muds containing abundant terrigenous material.

Calcareous sediment occasionally nannofossil rich.

105

SEISMIC REFLECTION RECORD | REFLECTION PICKS AT DRILL SITE | INTERVAL VEL. | INTERFACE PICKS | LITHOLOGY | AGE | DEPTH | % CLAY 100–0 / % SAND 0–100 | % SiO_2 100–0 / % $CaCO_3$ 0–100 | POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 105 LEG 11



SITE DATA

Position:
- Latitude 36°26.0' N
- Longitude 69°27.7' W

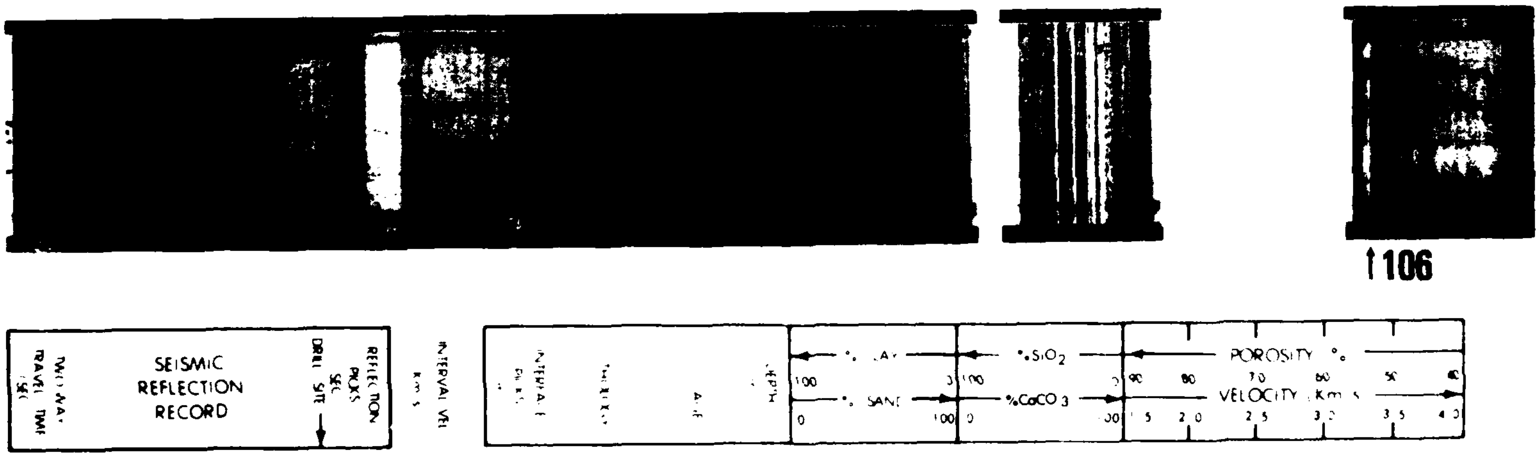
Date: 05/20/70
Time: 0550Z
Water Depth: 4500 meters
Location: Lower Continental Rise

CORE DATA

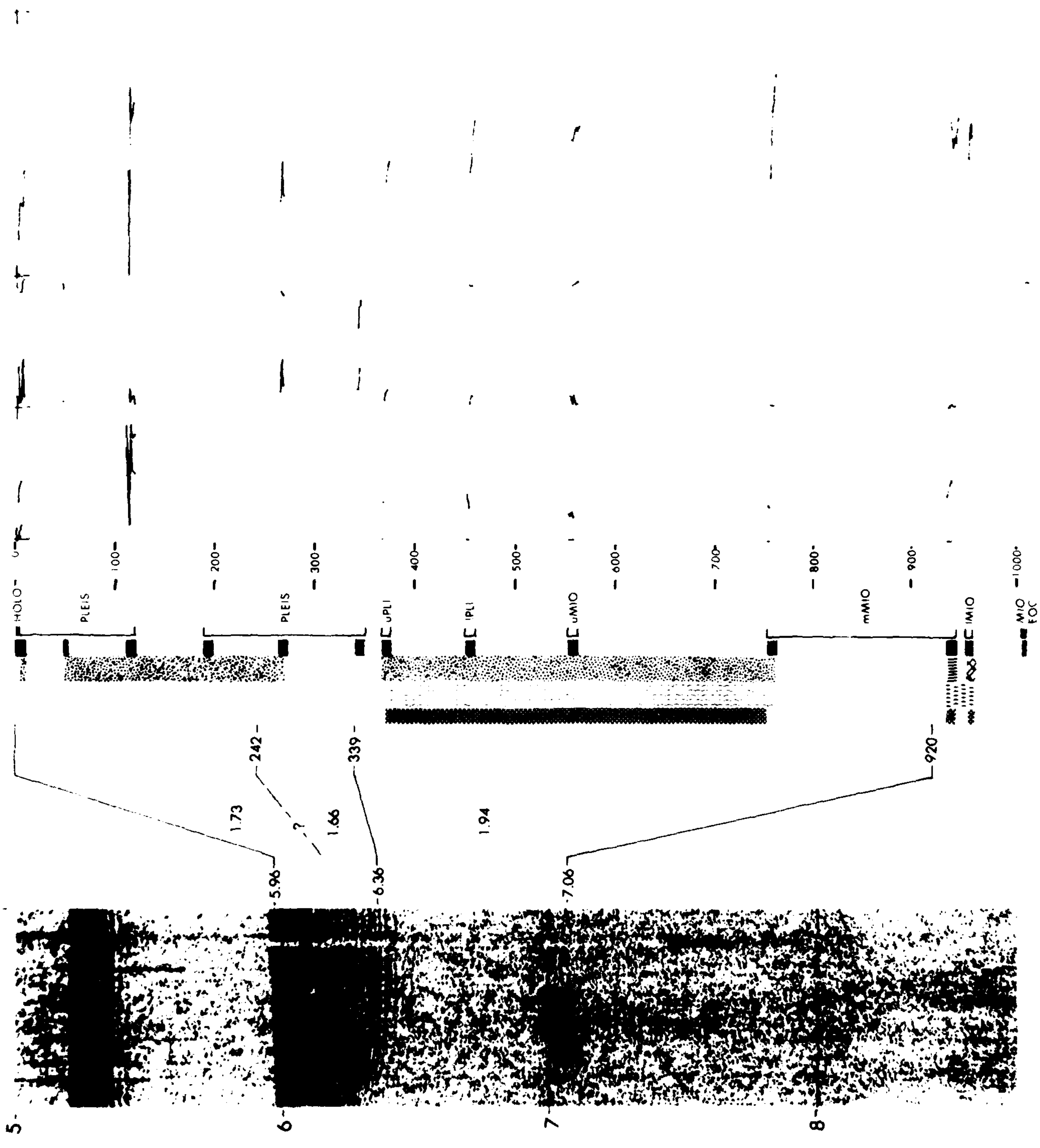
	106	106A	106B	
Penetration:				
Drilled----	301	361	960	meters
Cored----	48	0	56	meters
Total----	349	361	1015	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	6	0	8	cores
	22	0	39	meters

The highly stratified upper section consists of terrigenous sands, and sandy and silty clays that were emplaced during Pleistocene time by turbidity currents, probably from the Brandywine and Hudson canyons, and which accumulated in a large depression on the continental rise. The underlying transparent interval corresponds to a thick accumulation of well-indurated and faintly bedded, Tertiary hemipelagic mud that can be traced to the nearby lower continental rise. The upper section of this interval (late middle Miocene and late Miocene) is rich in carbonates, while the lower part (middle Miocene) is more siliceous. A good correlation can be established between Sites 102, 103, and 104 and this site, based on composition as well as paleontological correlation. Turbidites appear to be absent. The last two cores obtained from this site sampled a hard silicified zone, probably Eocene in age, which lies very close to the horizontal reflector situated at 1.1-second reflection time under the sea floor, and which shows continuity with Horizon A. However, the presence of the hiatus observed at Sites 99, 101, and 105 could not be established at this site, as drilling stopped before the layer beneath Horizon A could be sampled.

Thin Pleistocene detrital layers, mica rich.



SITE 106 LEG 11



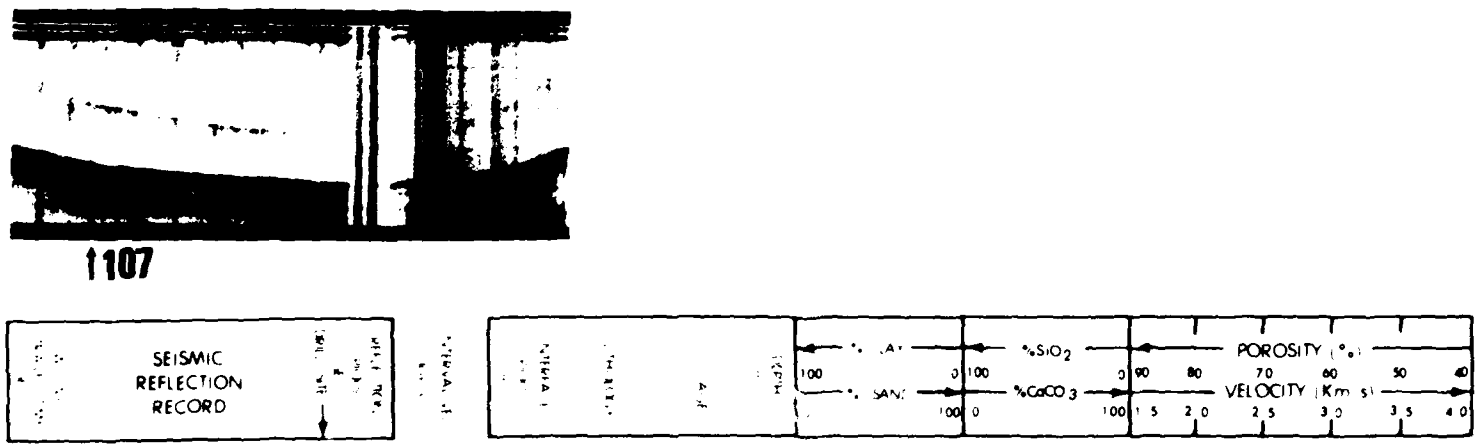
SITE DATA

Position:
Latitude 38°39.6' N
Longitude 72°28.5' W
Date: 05/31/70
Time: 1310Z
Water depth: 2571 meters
Location: Upper Continental Rise

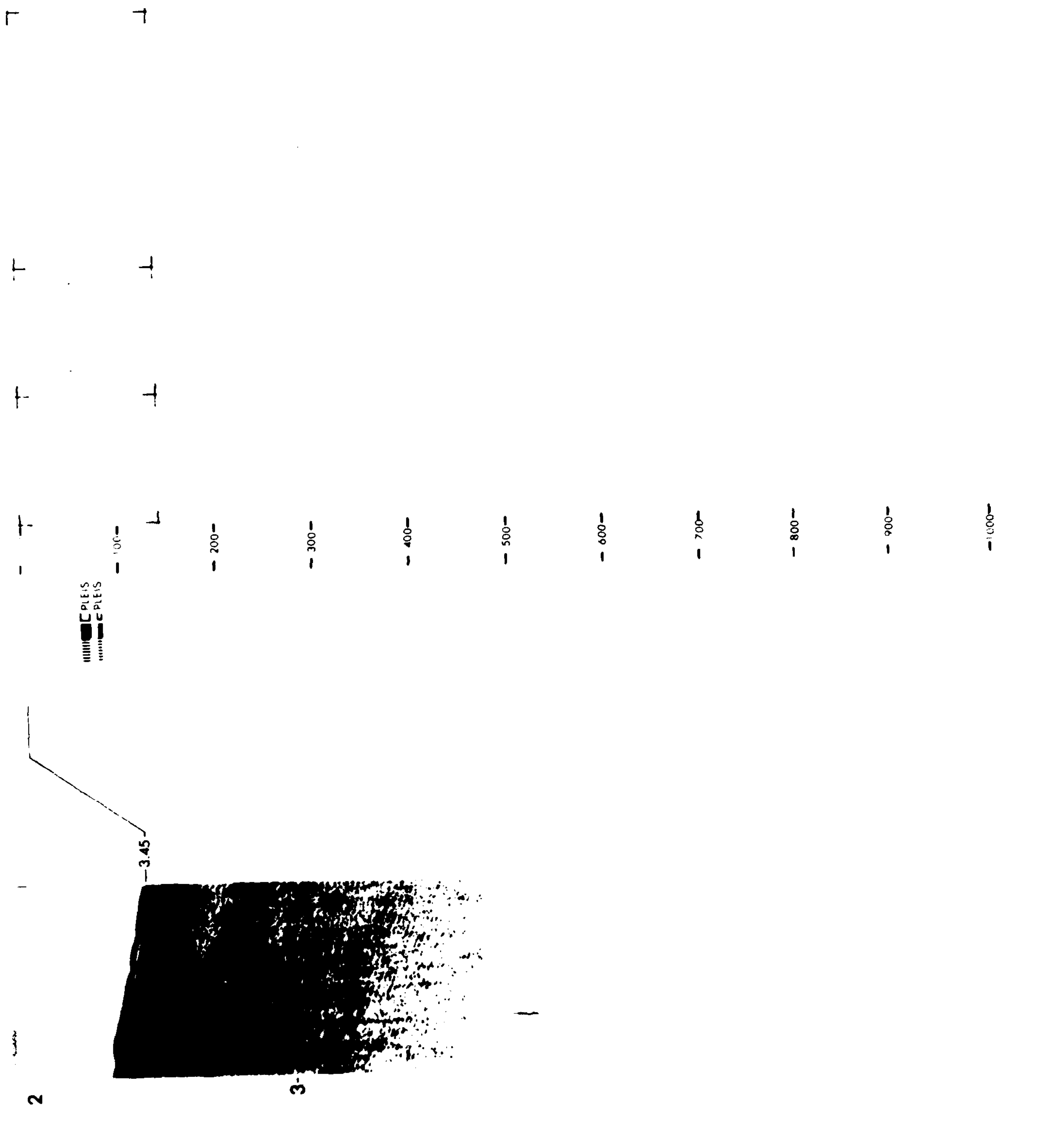
CORE DATA

Penetration:	
Drilled--	66 meters
Cored----	12 meters
Total----	78 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	2 cores
	1.5 meters

The two short cores recovered at this site contain dark gray silty to sandy clay (Figures 4 and 5). Over half the length of each core liner contained muddy and sandy water indicating that sand layers had been penetrated but not retained. Smear slides show that the hemipelagic mud is composed of approximately 25 per cent quartz, feldspar, and heavy mineral-rich sand and silt, and 75 per cent clay minerals, calcite/dolomite fragments, plant debris, and a sparse assemblage of foraminifera, nannoplankton, diatoms, and sponge spicules. Drilling at Site 107 penetrated displaced sediment containing a Pleistocene, inner sublittoral microfauna, with reworked Paleogene specimens, in a matrix of silty and sandy clay. Intervals of sand appear to have been penetrated, but were too loose to be retained in the core barrel.



SITE 107 LEG 11



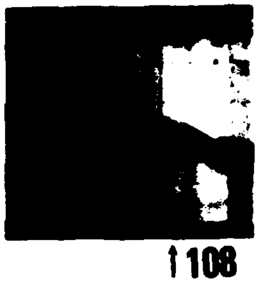
SITE DATA

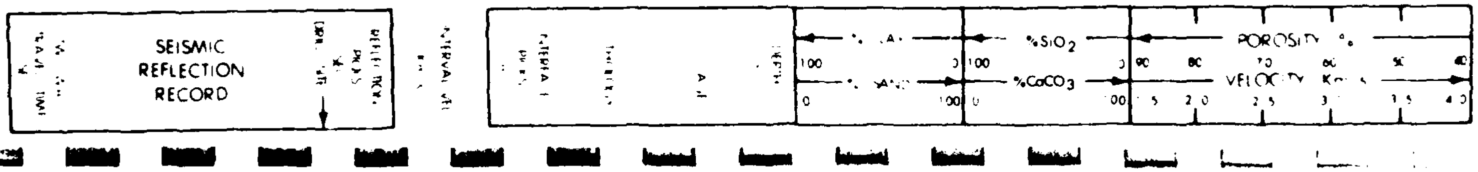
Position:
Latitude 38°48.3′ N
Longitude 72°39.2′ W
Date: 05/31/70
Time: 1530Z
Water depth: 1845 meters
Location: Continental Slope

CORE DATA

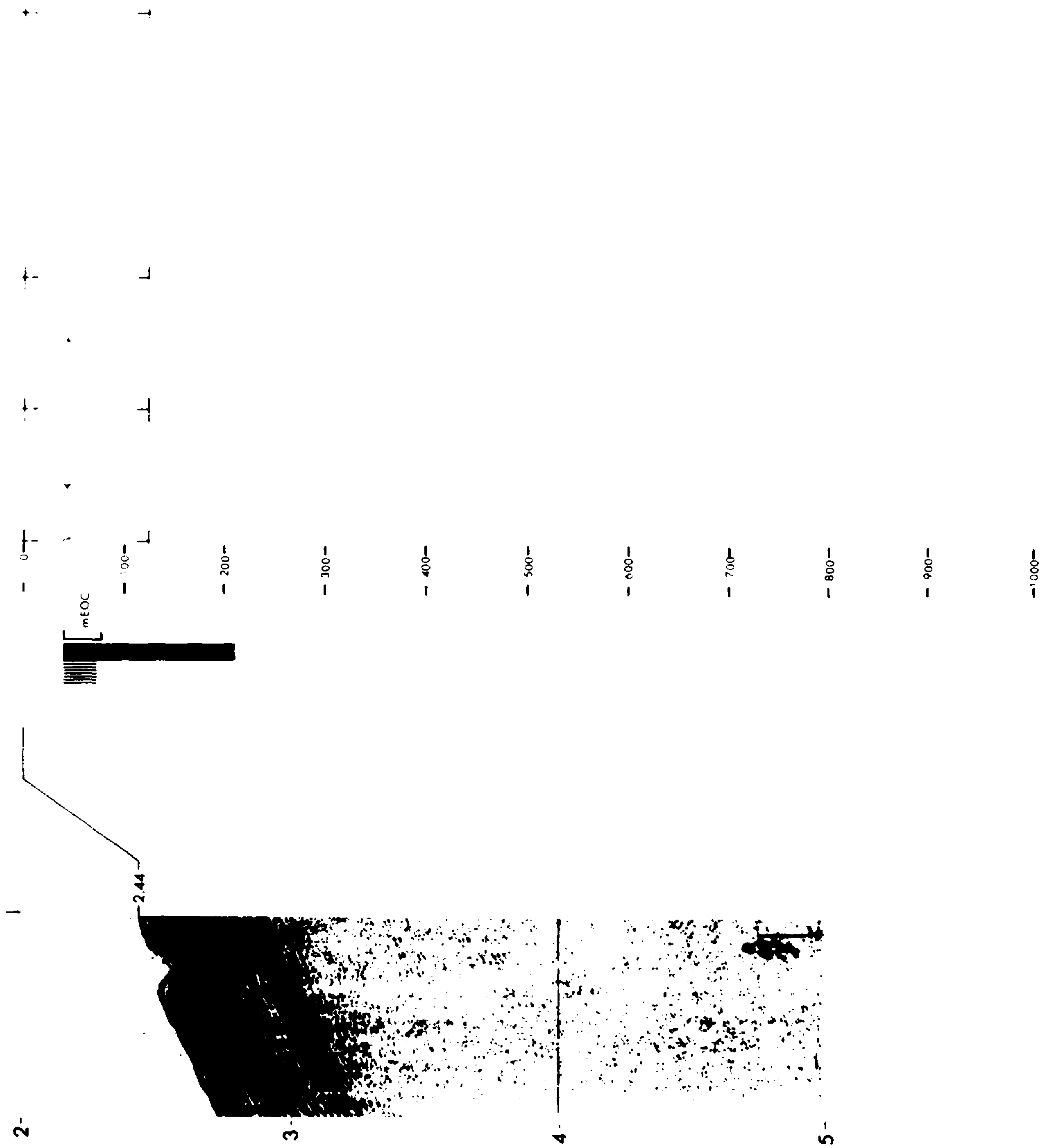
Penetration:
Drilled-- 173 meters
Cored---- 36 meters
Total---- 209 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 4 cores
7.2 meters

Both cores recovered at this site contain light greenish-gray, *radiolarian-nanno-plankton-foraminiferal ooze* of soft to firmly indurated consistency. The hard material shows little disturbance from coring other than cracking into sections 20 and 30 centimeters long. Moderate to intense mottling of the firmer sediment indicates considerable bioturbation. *Smear slides reveal abundant and well-preserved calcareous* nannoplankton, foraminifera, diatoms, radiolarians, sponge spicules, and rare glauconite particles. No terrigenous components were observed.





SITE 108 LEG 11



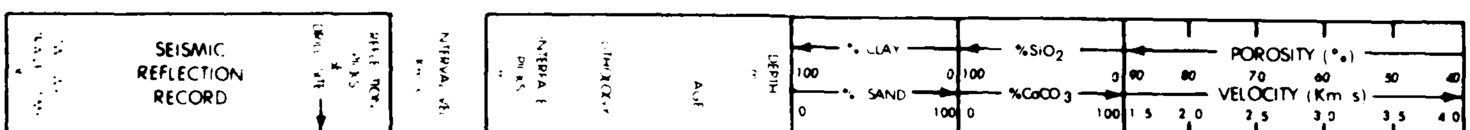
SITE DATA

Position:
    Latitude   37° 59.0' N
    Longitude 71° 46.7' W
Date:
Time:
Water depth:
Location:

CORE DATA

Penetration:
    Drilled--   meters
    Cored----   meters
    Total----   meters
Recovery:
    Basement-   cores
                 meters
    Total----   cores
                 meters

No information given for this site.



SITE 109 LEG 12

0 100 200 300 400 500 600 700 800 900 1000

SITE DATA		CORE DATA		
Position:		Penetration:		
Latitude	[illegible]8° 02.9' N	Drilled--		meters
Longitude	71° 45.6' W	Cored----		meters
Date:		Total----		meters
Time:		Recovery:		
Water depth:		Basement-		cores
Location:				meters
		Total----		cores
				meters

No information given for this site.

SEISMIC REFLECTION RECORD	DEPTH	% CLAY 100 — 0 / % SAND 0 — 100	%SiO2 100 — 0 / %CaCO3 0 — 100	POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 110 LEG 12

0 100 200 300 400 500 600 700 800 900 1000

SITE DATA

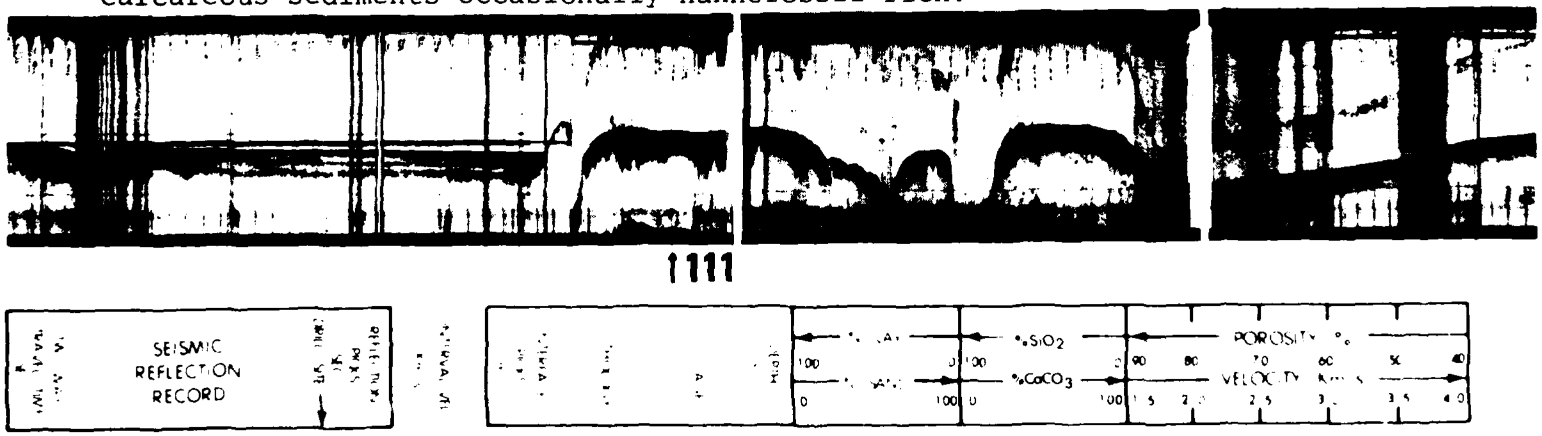
CORE DATA

Position:	
Latitude	50°25.6′N
Longitude	46°22.0′W
Date:	06 28 70
Time:	0535Z
Water depth:	1797 meters
Location:	Orphan Knoll; east of Newfoundland

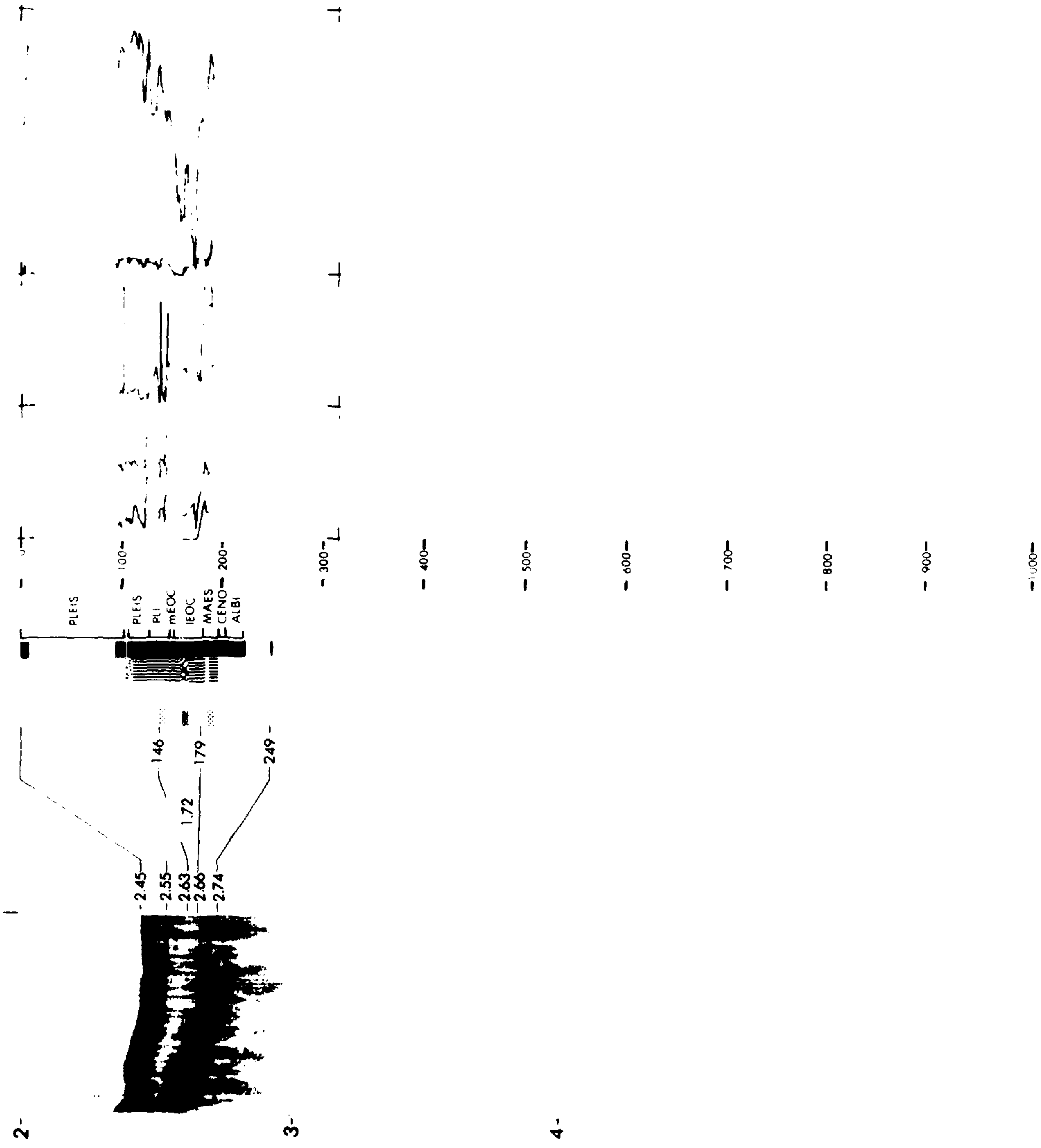
Penetration:	111	111A	
Drilled----	202	105	meters
Cored-----	48	94	meters
Total----	250	199	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	7	12	cores
	15	59	meters

Four definite unconformities were encountered; (1) Late Miocene/Late Eocene. At approximately 147 meters a distinct unconformity occurs marked by a thin glauconite sand layer. The hiatus in deposition represents approximately 30 million years. (2) Early Eocene/Late Maestrichtian—at about 180 meters. The estimated lapse in time is 13.5 million years. (3) Late Maestrichtian/Middle Cenomanian. A manganese encrusted calcarenite occurs at about 189 meters, immediately below calcareous oozes of Late Maestrichtian age. Approximately 30 million years are missing. (4) Albian/Jurassic (Bajocian)—64 million years. Although only 67 centimeters of the lowermost Bajocian sandstone was recovered, it has proved most interesting. Both the petrologic and paleontological investigations have suggested either a nonmarine or very shallow coastal environment; this along with the presence of immature sediments and anthracite fragments has confirmed the suspected continental nature of the Orphan Knoll block. Coal measures were laid down near the drilling site during the Carboniferous (?); and later when the whole area was metamorphosed by the Hercynian (?) orogeny, the coal was transformed to anthracite. From this point to the present the geological history is a sinking history of the knoll.

Calcareous sediments occasionally nannofossil rich.



SITE 111 LEG 12

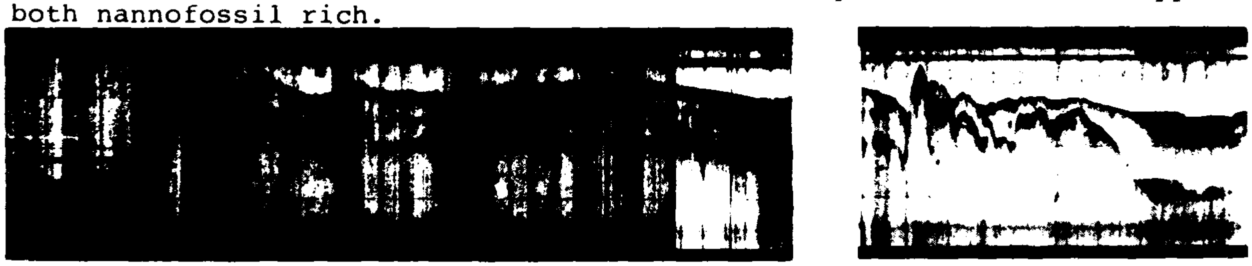


54 01.0' N
46 36.2 W
07 03 70
1616.
3657
Near basement ridge in the South Labrador Sea

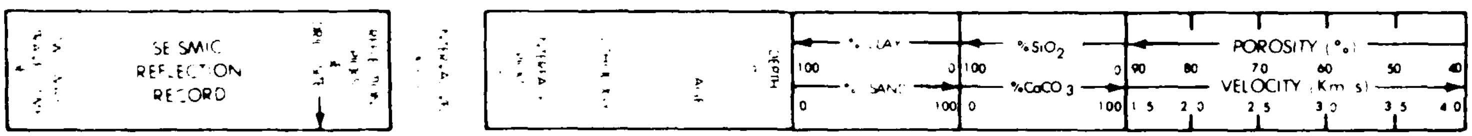
	112	112A	
[illegible]	519	79	meters
[illegible]	145	45	meters
Total----	664	124	meters
Recovery:			
Basement-	2	0	cores
	1.2	0	meters
Total----	17	5	cores
	75	32	meters

We can assume that sedimentation has been influenced, at least since Oligocene times, by a bottom current which brought arctic bottom water and sediment particles into the Labrador Sea. Assuming that the current was controlled by the bottom topography, which is represented by a semicircle of basement ridges on the Labrador Sea floor it must have moved in a southeasterly direction in the area of Site 112. Within the ridges it discharged the sediments most probably out of the "nepheloid layer" whose existence through the Cenozoic might be assumed. It is more difficult to explain the differences with respect tothe total organic content of the sediments. Certainly this was partly controlled by the surface "Gulf Stream" which must have gone the opposite way relative to the bottom current, thus circling dextrally in the Labrador Sea through Mesozoic and Cenozoic times until glaciation started in the Pliocene. With the onset of glaciation in the Pliocene, the situation changed. The Arctic bottom current still kept flowing in approximately the same direction, but on the surface the warm Gulf Stream was replaced by the cold East Greenland and Labrador streams. The absence of siliceous microfossils could thus be explained by a radical change of biotope.

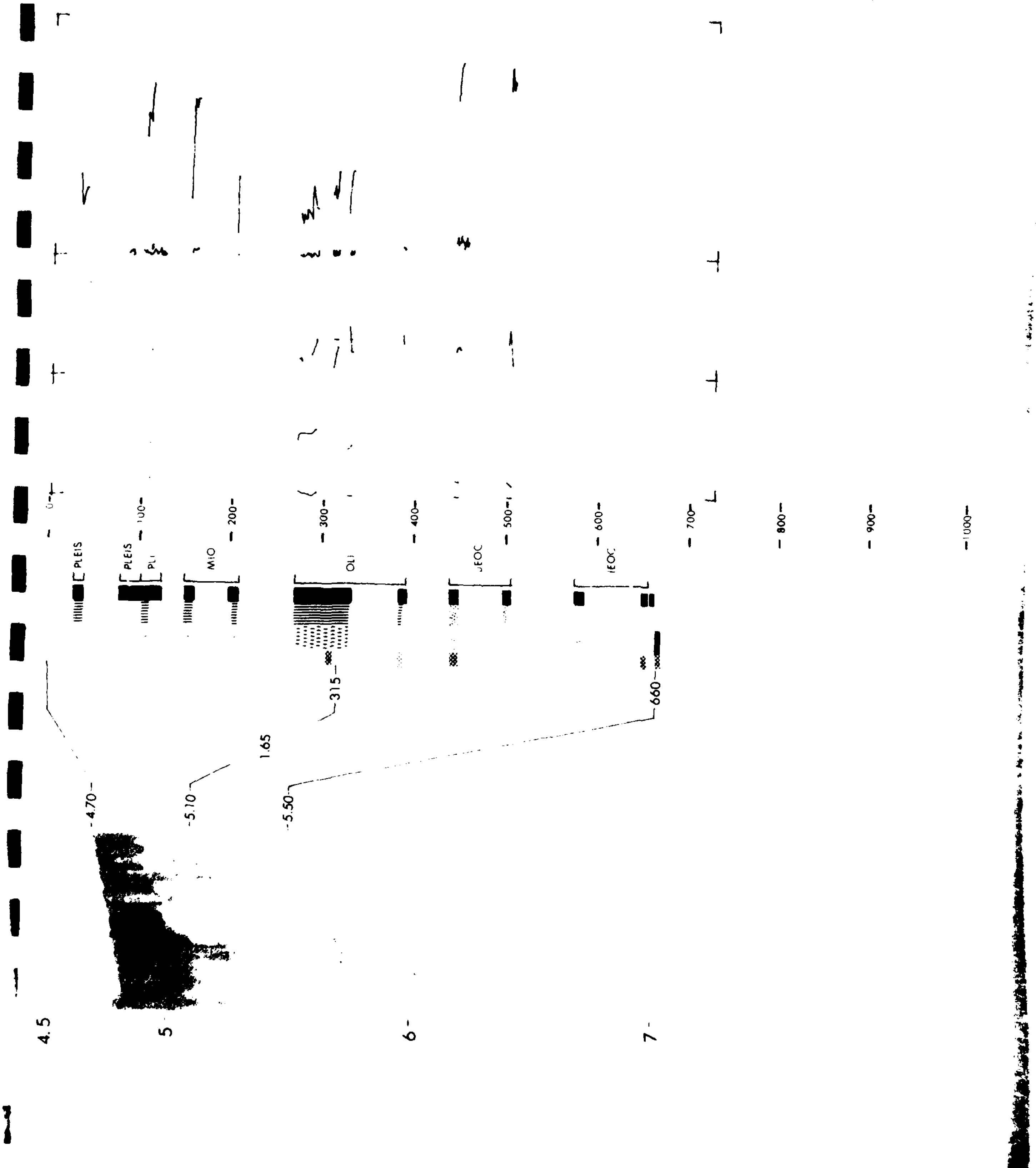
Calcareous sediment in thin beds, one in Oligocene and one in upper Eocene time, both nannofossil rich.



112



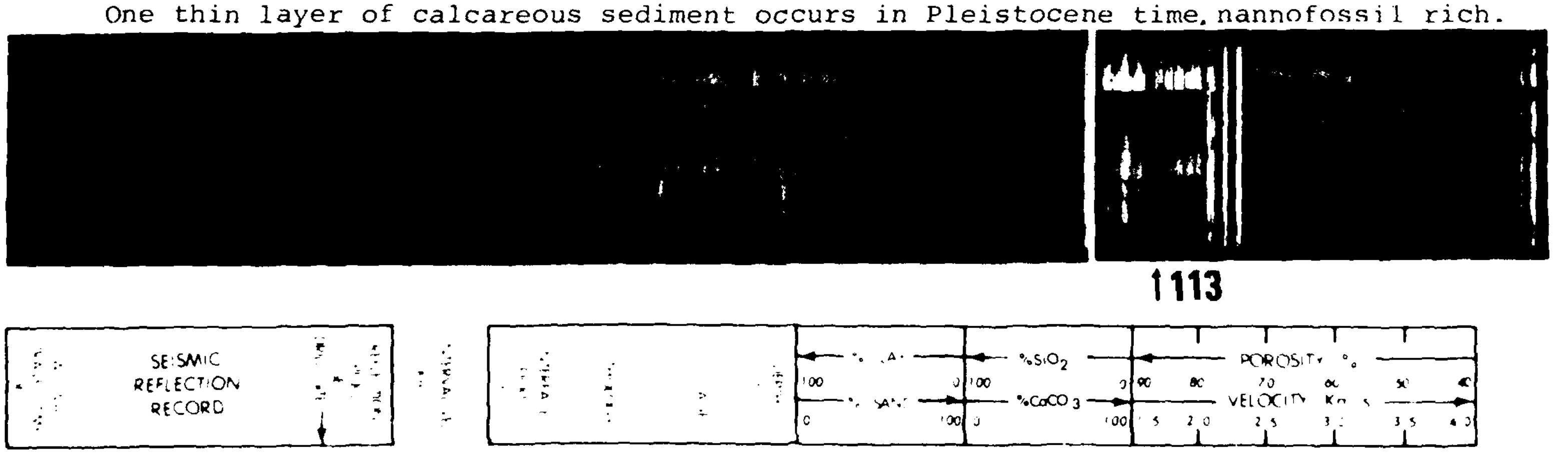
SITE 112 LEG 12



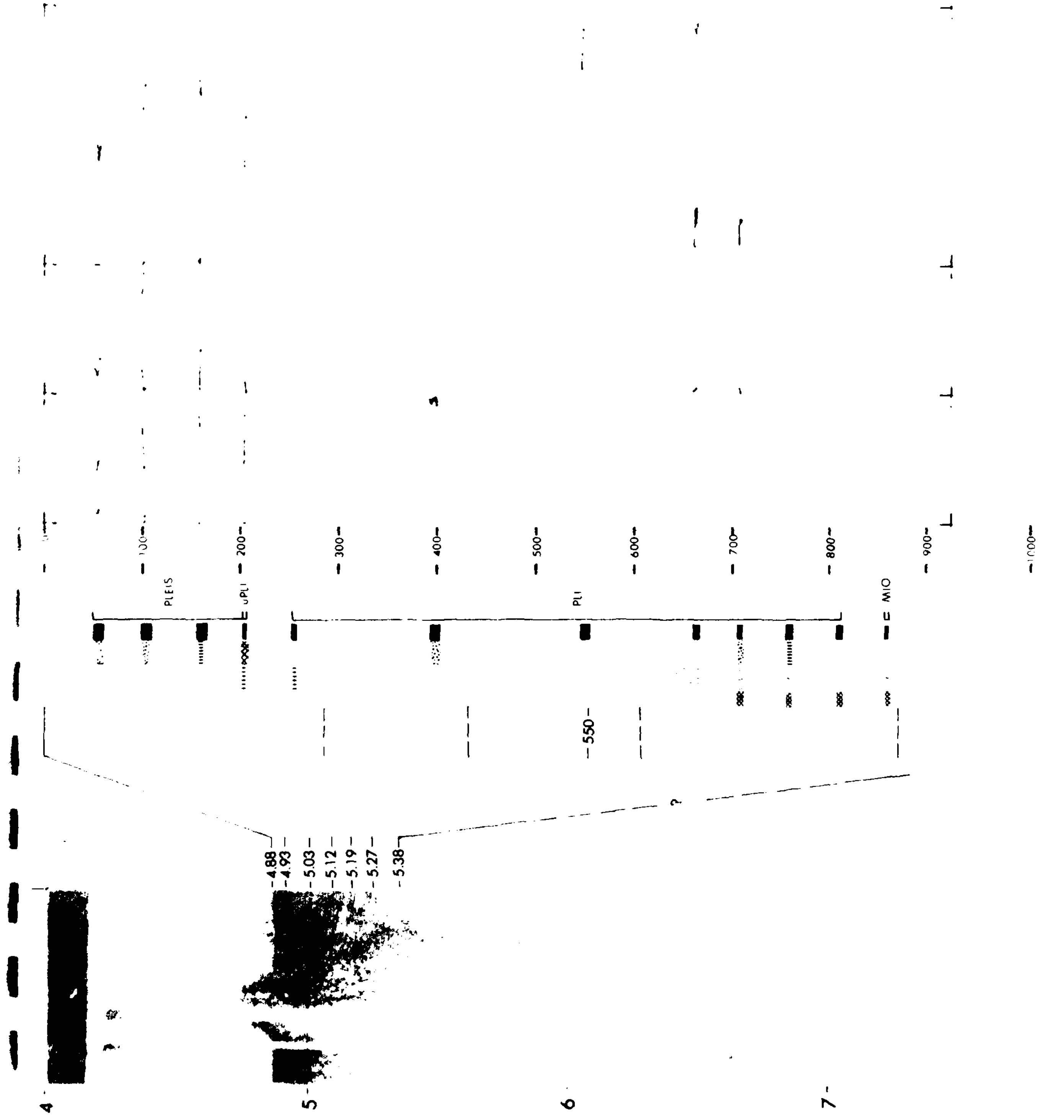
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	56° 47.4' N	Drilled--	847 meters
Longitude	48° 19.9' W	Cored----	76 meters
Date: 07/04/70		Total----	923 meters
Time: 1940Z		Recovery:	
Water depth: 3619 meters		Basement-	0 cores
Location: Axis of Labrador Sea			0 meters
		Total----	12 cores
			31 meters

Site 113 was the locus of deposition of over 900 meters of Late Miocene to Pleistocene terrigenous sediments. The upper 550 meters are related to Late Pliocene-Pleistocene glaciation and consist of silts, sands, clays and abundant rafted pebbles. The lower part of the sequence consists of laminated mudstones and siltstones. The origin of much of the sequence is attributed to turbidity currents derived from Greenland and Labrador. Sediments of the lower half of the hole were trapped within the confines of a narrow valley which was probably anaerobic during the deposition of the lower turbidite sequence. Of particular interest is a mudflow sequence found in Core 7. Alternating layers of gray-green micaceous clay and "breccia" layers contain reworked coccoliths as old as Eocene. The sedimentary sequence has been explained as the result of stripping of exposed Eocene to Pliocene sediments on the nearby hill which might be topped by uplifted early Tertiary sediments. The mudstone sequence exhibits a distinct laminated pattern with an average thickness of a single lamina of less than 1 millimeter. The sequence may have been the result of periodic deposition from the distal parts of turbidity currents, or from nepheloid layers associated with bottom currents.

One thin layer of calcareous sediment occurs in Pleistocene time, nannofossil rich.



SITE 113 LEG 12



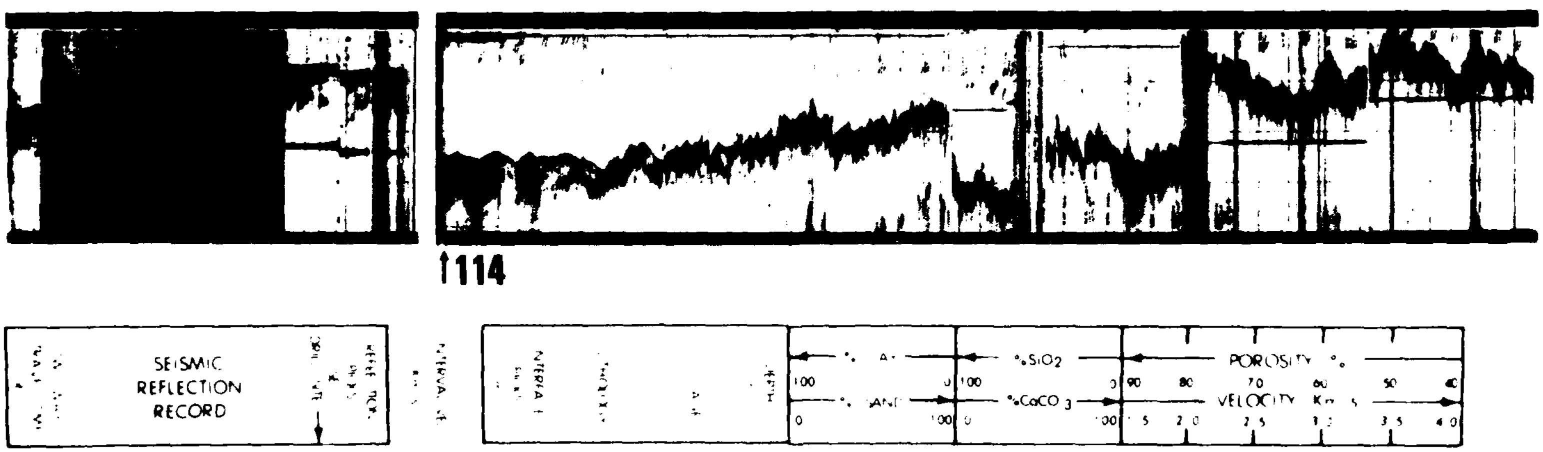
SITE DATA

Position:
Latitude 59°56.0' N
Longitude 26°48.0' W
Date: 07/11/70
Time: 1530Z
Water depth: 1927 meters
Location: East flank of Reykjanes Ridge; Anomaly 5

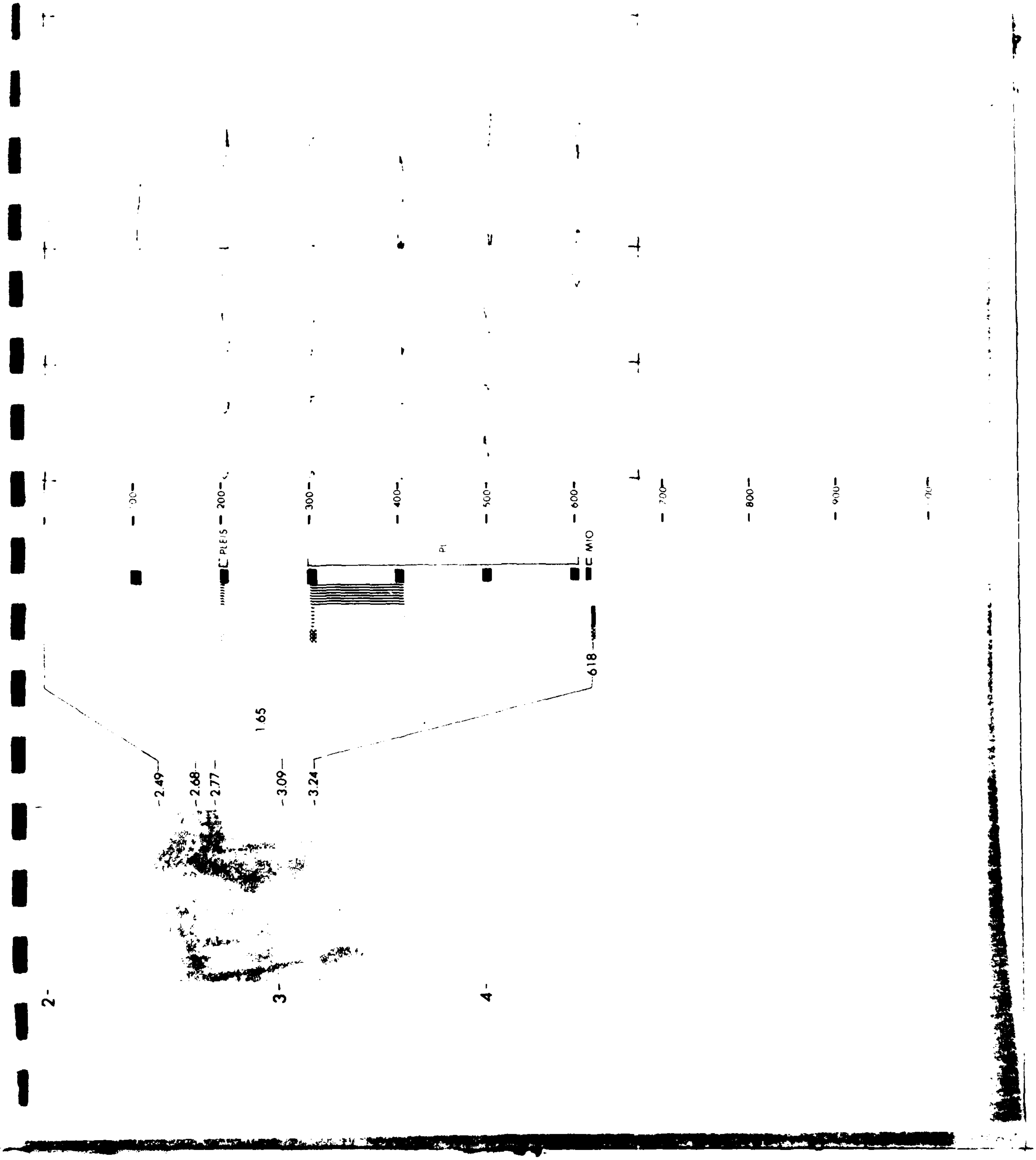
CORE DATA

Penetration:
Drilled-- 563 meters
Cored---- 60 meters
Total---- 623 meters
Recovery:
Basement- 3 cores
.3 meters
Total---- 9 cores
46 meters

The main objective of drilling at this site was to determine whether there was evidence for a hiatus in sea floor spreading prior to Anomaly 5 (10 million years) which could account for the abrupt increase in sediment thickness east of the scarp associated with the anomaly. The age of the oldest sediments is considerably younger than that required even of a continuous spreading theory and we therefore conclude that there is no evidence here of a hiatus in sea-floor spreading. The sediments sampled were predominantly clays and silts with relatively little carbonate. The bulk was terrigenous material containing abundant volcanic products Much of this may have been derived from the finer fraction of volcanic material deposited on the continental shelf and slope south of Iceland. We know from the sediments recovered at Hole 115, that turbidity currents originate on this slope carrying the coarser material into the deep part of the Iceland Basin. Two large canyons in the rise are probably cut by turbidity currents. The finer fractures may get incorporated into the westerly going bottom currents and be deposited on the flanks of the Reykjanes Ridge. Seismic profiles south of Iceland show considerable accumulations of sediment which may have been redistributed in this way.



SITE 114 LEG 12



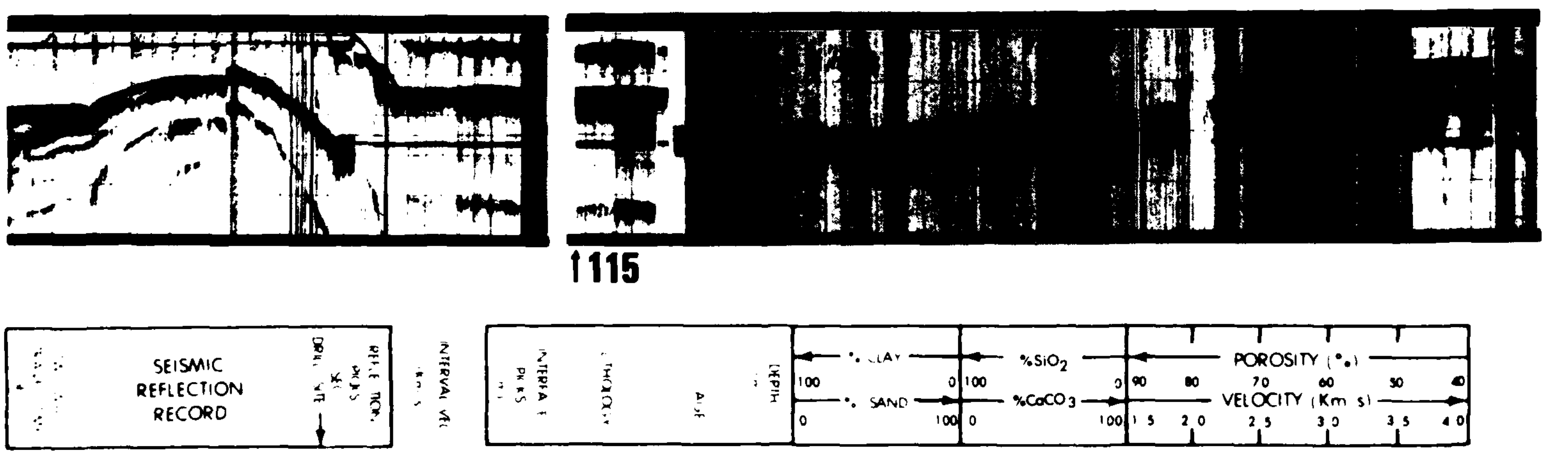
SITE DATA

Position:
Latitude 58°54.4' N
Longitude 21°07.0' W
Date: 07/14/70
Time: 0850Z
Water depth: 2883 meters
Location: Basin east of Reykjanes Ridge at Anomaly 22

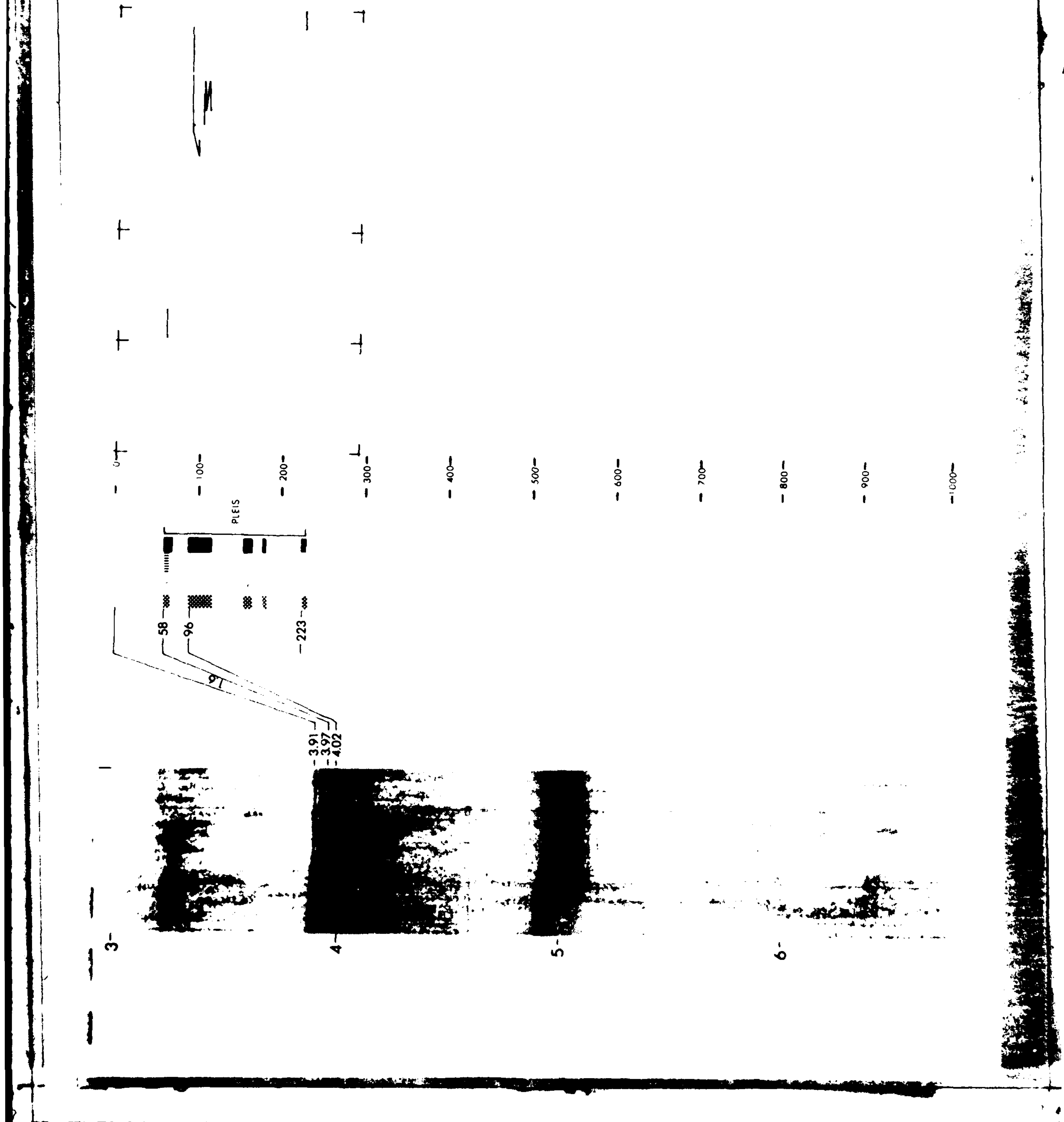
CORE DATA

Penetration:
Drilled-- 172 meters
Cored---- 55 meters
Total---- 227 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 8 cores
11 meters

The petrological and lithological descriptions of the sandstones have shown that they are the product of submarine or subglacial volcanic eruptions providing a source of hyaloclastic glassy basalts. The good sorting, graded bedding and internal stratification of individual layers suggest that the sediments have been deposited by a turbidity current mechanism. Induration has occurred subsequent to deposition. The age of the volcanic glass, judged from the degree of palagonitization, the nature of the hyaloclastites and the topography of the Iceland Basin as a control on transport paths, all point to Iceland as the provenance. Volcanic eruptions were especially frequent under the ice sheet during the glacial period, generating glacier floods or jökulhlaups carrying large quantities of hyaloclastics. These eventually debauch onto the continental shelf and could traverse it as turbidity currents. The indurated volcanogenic sandstones and the softer intervening clays were derived from Quaternary volcanic activity in Southern Iceland, crossing the shelf and traveling down the submarine canyons as mud flows or turbidity currents, and finally ponding and depositing in the Iceland Basin. Chemical induration of the lower parts of the turbidites took place in situ.



SITE 115 LEG 12



SITE DATA

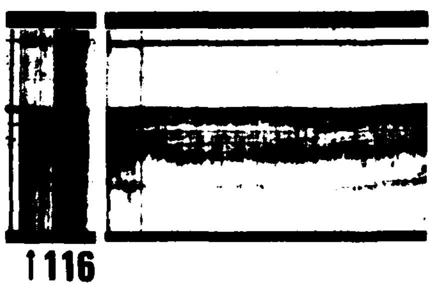
Position:
Latitude $57^{\circ}29.8'$ N
Longitude $15^{\circ}55.5'$ W
Date: 07/21/70
Time: 2013Z
Water depth: 1151 meters
Location: East side of Hatton-Rockall Basin

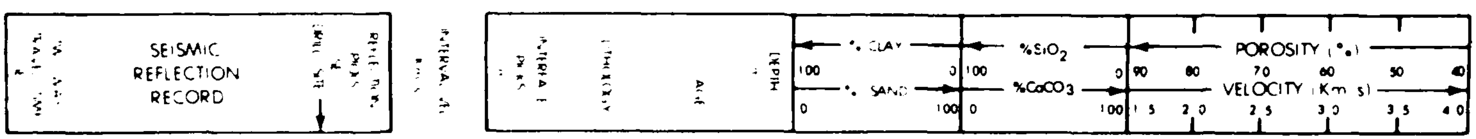
CORE DATA

Penetration:	116	116A	
Drilled--	628	0	meters
Cored----	226	99	meters
Total----	854	99	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	28	11	cores
	195	89	meters

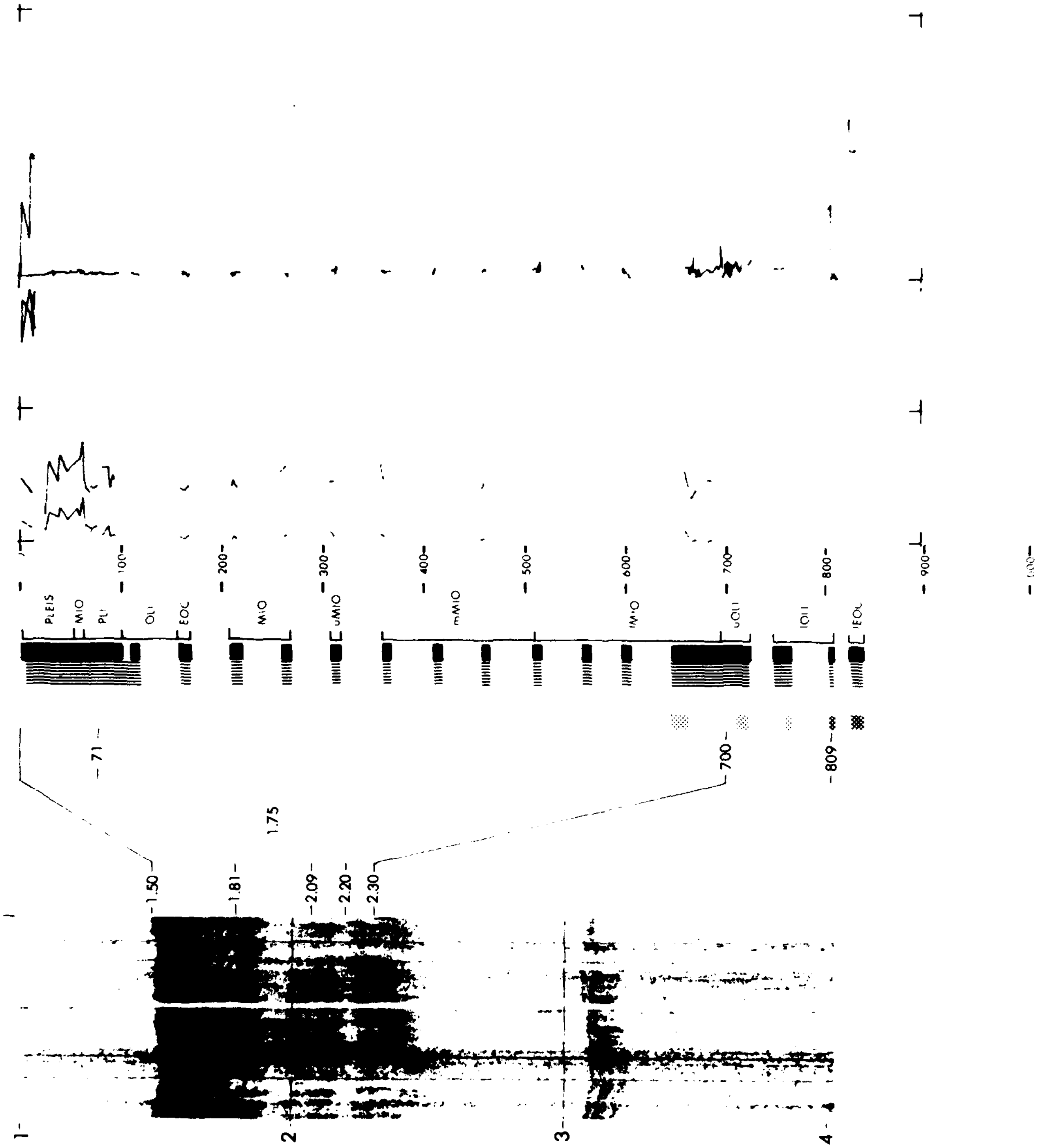
Site 116 and Site 117 are discussed together. The hole at site (116) terminated at 854 meters in cherty limestones of Late Eocene age. In order to reach lower stratigraphic levels drilling was continued at a new site (117) to the east on the lower flanks of the Rockall Bank where seismic profiling showed that the subsurface strata was considerably more shallow. A relatively complete sequence of Cenozoic sediments is present in the Hatton-Rockall Basin. The gradual sinking of this basin to its present depth during the Cenozoic is reflected in the nature of the sediments: predominantly detrital in the lower part, with a gradually increasing proportion of pelagic material in the younger horizons. Two unconformities were recorded: at Site 116 between the Upper Oligocene/Lower Oligocene-representing a time-interval of about 10 million years: at Site 117 between the Oligocene/Lower Eocene-representing about 20 million years. The sequential sinking of Hatton-Rockall Bank is reflected in the microfaunas so that one obtains a picture of the gradual development of deeper water benthonic faunas in addition to the climatically induced changes in planktonic foraminiferal faunas.

Calcareous sediment foraminifera and one sample nannofossil rich.





SITE 116 LEG 12



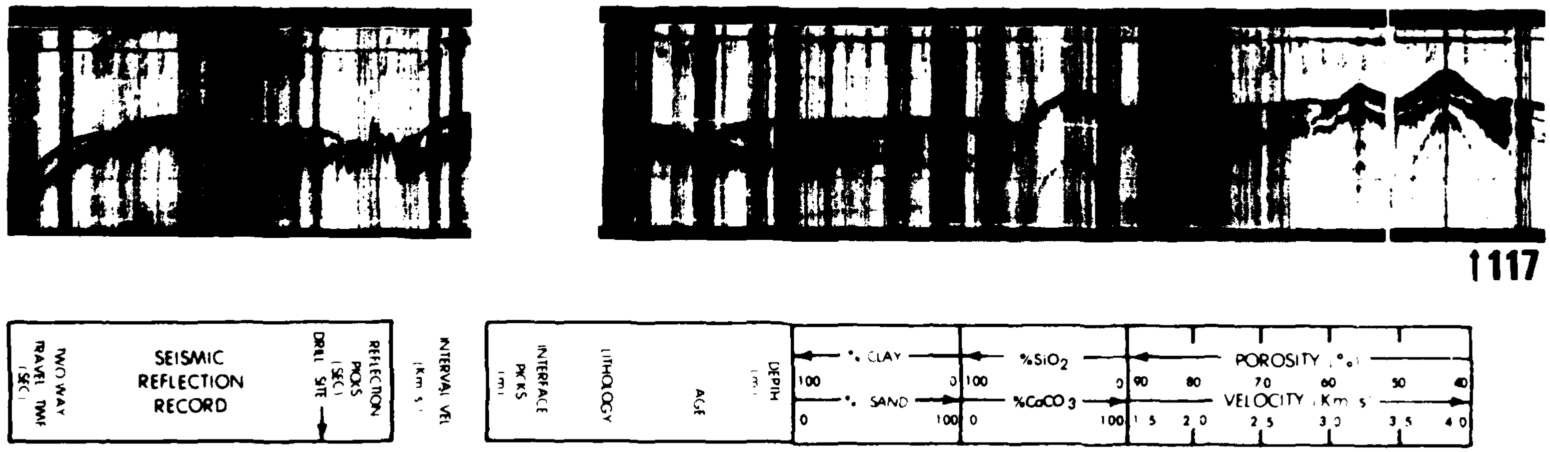
SITE DATA

Position:
  Latitude 57°20.2' N
  Longitude 15°24.0' W
Date: 07/21/70
Time: 2235Z
Water depth: 1038 meters
Location: East side of Hatton-Rockall Basin

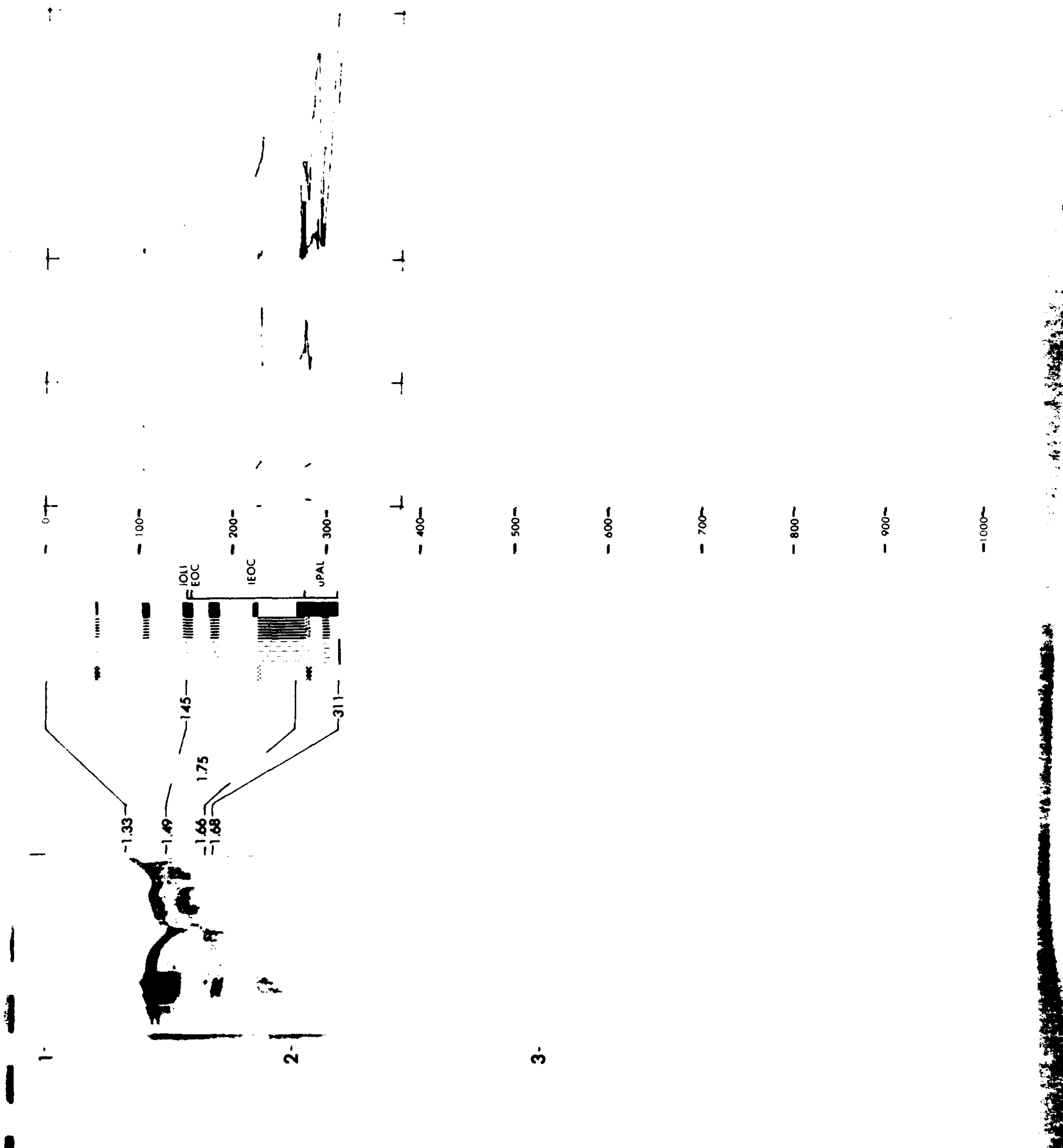
CORE DATA

Penetration:	117	117A	
Drilled--	136	247	meters
Cored----	20	66	meters
Total----	156	313	meters
Recovery:			
Basement-	0	1	cores
	0	1.8	meters
Total----	3	11	cores
	8.5	34	meters

Site 116 and Site 117 are discussed together. The lithology recovered from both holes can be divided into 4 units. The upper unit is a foraminiferal nannofossil ooze, foraminiferal sand and silty clay. Second is a limestone, chalk and ooze unit overlying clay and basal sediments. The "basement" is a weathered and fractured olivine basalt in which the cracks are partly filled with micritic or zeolitic calcisparite.



SITE 117 LEG 12



SITE DATA

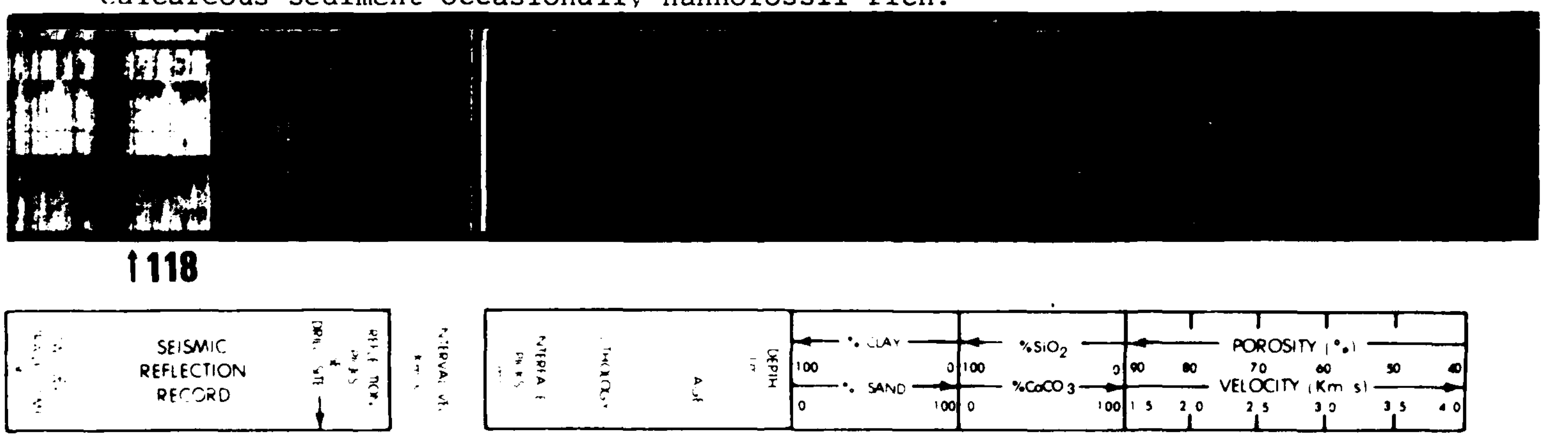
Position:
Latitude 45°02.6' N
Longitude 9°00.6' W
Date: 07/29/70
Time: 0075Z
Water depth: 4901 meters
Location: Western Biscay Abyssal Plain

CORE DATA

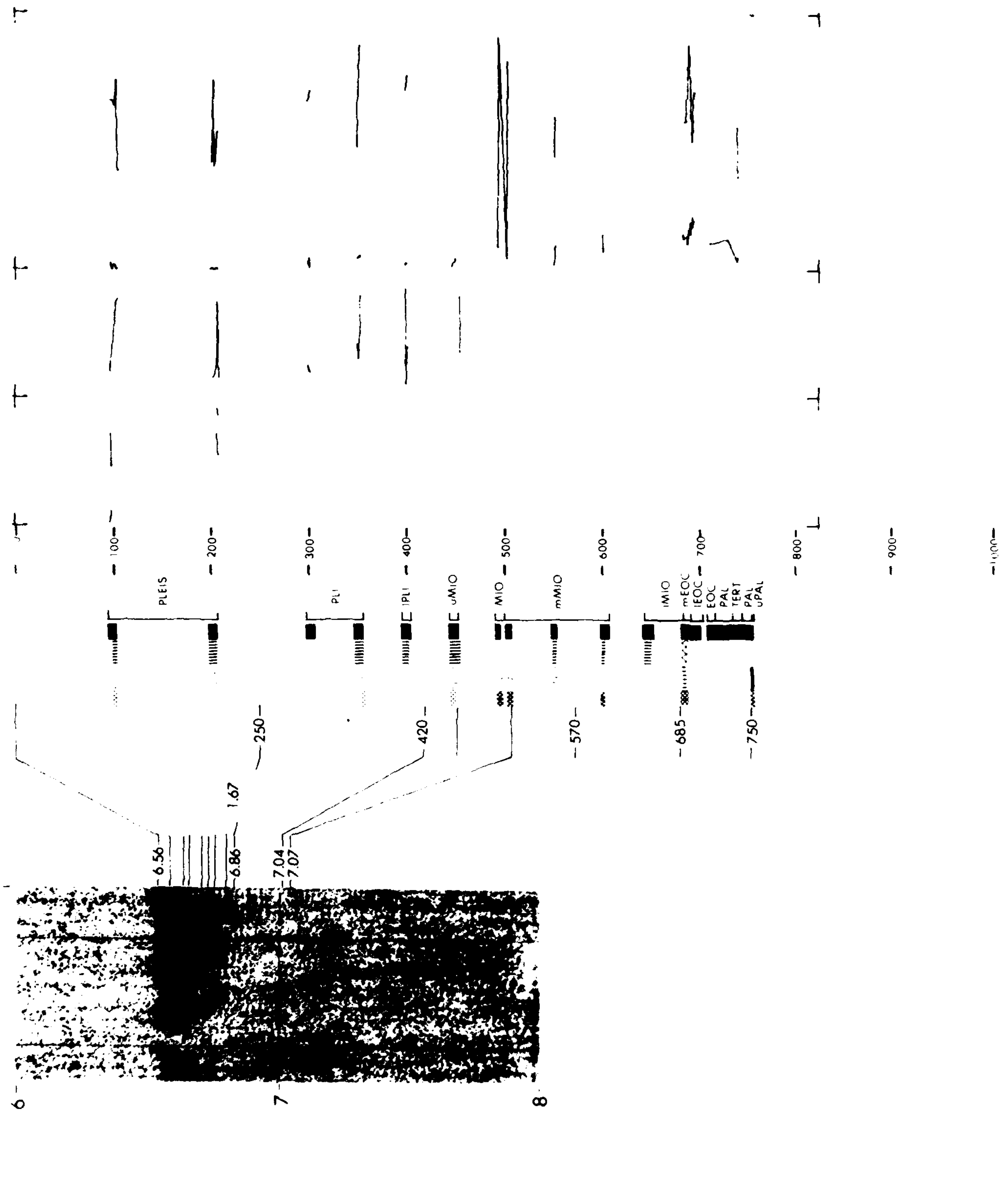
Penetration:
Drilled-- 614 meters
Cored---- 147 meters
Total---- 761 meters
Recovery:
Basement- 3 cores
2.1 meters
Total---- 21 cores
52 meters

The Miocene-Pleistocene sediments are primarily turbidity current deposits; the Paleocene-Eocene sediments are of pelagic origin but exhibit evidence of slumping and micro-faulting. The upper turbidites are related to late Cenozoic glaciation and increased run off; the lower turbidites are probably related to various phases of the Alpine Orogeny. An unconformity at about 685 meters separated Lower Miocene/Middle Eocene strata, representing a time interval of about 32 million years. Hole 118 bottomed in weathered and oxidized basalt similar to that found on the flanks of mid-ocean ridges and belonging to the group of ocean floor basalts. A few meters above the basalt of Core 21, a sill of similar basalt about half a meter thick was penetrated, and the intervening sediments were baked red clay, thought to have been incorporated into the basalt sill while still fluid. The presence of one sill suggests that the lower basalt might also be a sill and that older sediments may be found below. The turbidite succession consists predominantly of dark olive gray silty clays, with quite a varied mineralogy, interbedded with pale gray coccolith-rich clays. Although they are basically pelagic sediments, the coccolith clays have a significant terrigenous contribution so they should, perhaps, not be described as oozes.

Calcareous sediment occasionally nannofossil rich.



SITE 118 LEG 12



SITE DATA

Position:
Latitude 45 °019 N
Longitude 7 °58.5W
Date: 08 /02/70
Time: 2030 Z
Water depth: 4447 meters
Location: Cantabria Seamount; Bay of Biscay

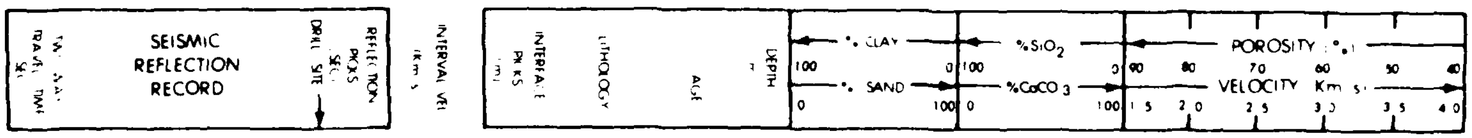
CORE DATA

Penetration:
Drilled-- 343 meters
Cored---- 368 meters
Total---- 711 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 40 cores
192 meters

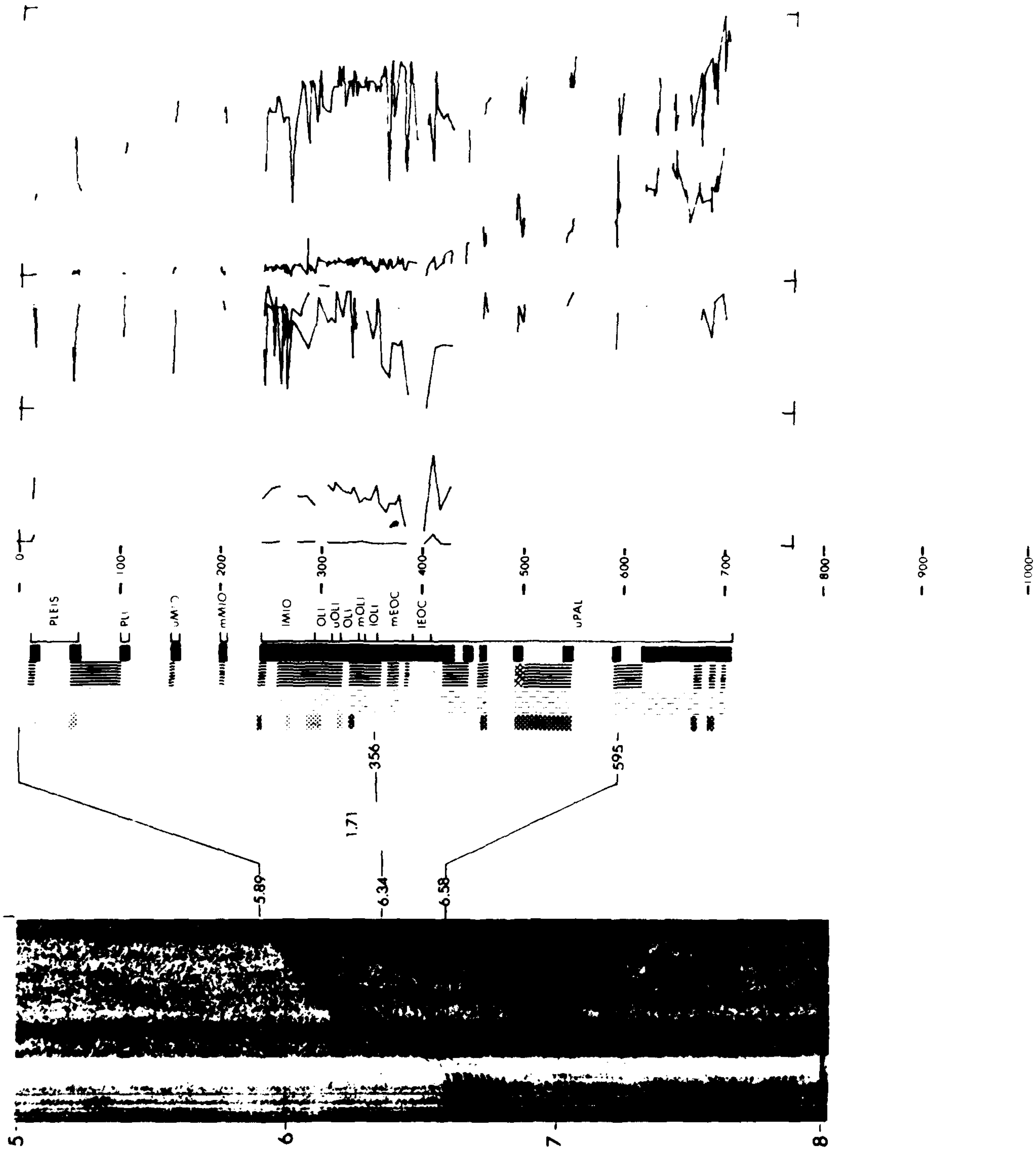
An unconformity which separates Lower Oligocene and Middle Eocene strata was encountered at about 360 meters. This hiatus representa a time-internal of about 8 million years. The sediments below the Middle Eocene/Oligocene unconformity have been recognized as turbidites and pelagic red clays deposited below the carbonate compensation depth, whereas those above are pelagic nannofossil clays. The sediments indicate a tectonic uplift of Cantabria at this time. The unconformity probably represents an erosional surface after the uplift of Cantabria Seamount during the Middle or Late Eocene. The underlying sediments show evidence of this tectonic disturbance. An objective of Hole 119 was to penetrate reflector 1, believed before we drilled, to be Maestrichtian and outcropping on the northeastern scarp (Jones and Funnell, 1968). The failure to reach Maestrichtian at 711 meters, well below reflector 1, prompted a re-examination of the Discovery-11 data which Jones and Funnell studied.

Calcareous, mostly nannofossil rich, sediments interbedded with few thin layers of detrital or siliceous sediment.

119



SITE 119 LEG 12



SITE DATA

Position:
Latitude $36^{\circ}41.4'$ N
Longitude $11^{\circ}25.9'$ W
Date: 8/14/70
Time: 1820Z
Water depth: 1711 meters
Location: Gorringe Bank

CORE DATA

Penetration:
Drilled-- 228 meters
Cored---- 26 meters
Total---- 253 meters
Recovery:
Basement- 1 cores
1.7 meters
Total---- 8 cores
6.2 meters

Cored Lower-Middle Miocene and Lower Cretaceous (Albian, Aptian, Barremian) gray and green, partly silicified nannofossil ooze. Bottomed in basement consisting of spilitic basalt, serpentinite, and meta-gabbro. The inferred stratigraphic section contains two significant unconformities: (1) a hiatus in bathypelagic sedimentation between the Cretaceous and the Miocene; (2) an abrupt change in sediment facies between Cretaceous-Miocene silicified nannofossil ooze yielding poor assemblages of planktonic foraminifera (suggestive of original deposition near or below the lysocline) and younger chalks and oozes unaffected by solution with rich, diverse assemblages. We interpret that the slab of oceanic crust drilled was uplifted from abyssal depths to its present position as a linear bank during a period of compression along the Azores-Gibraltar seismic zone that commenced in post-Langhian and pre-Tabianian time.

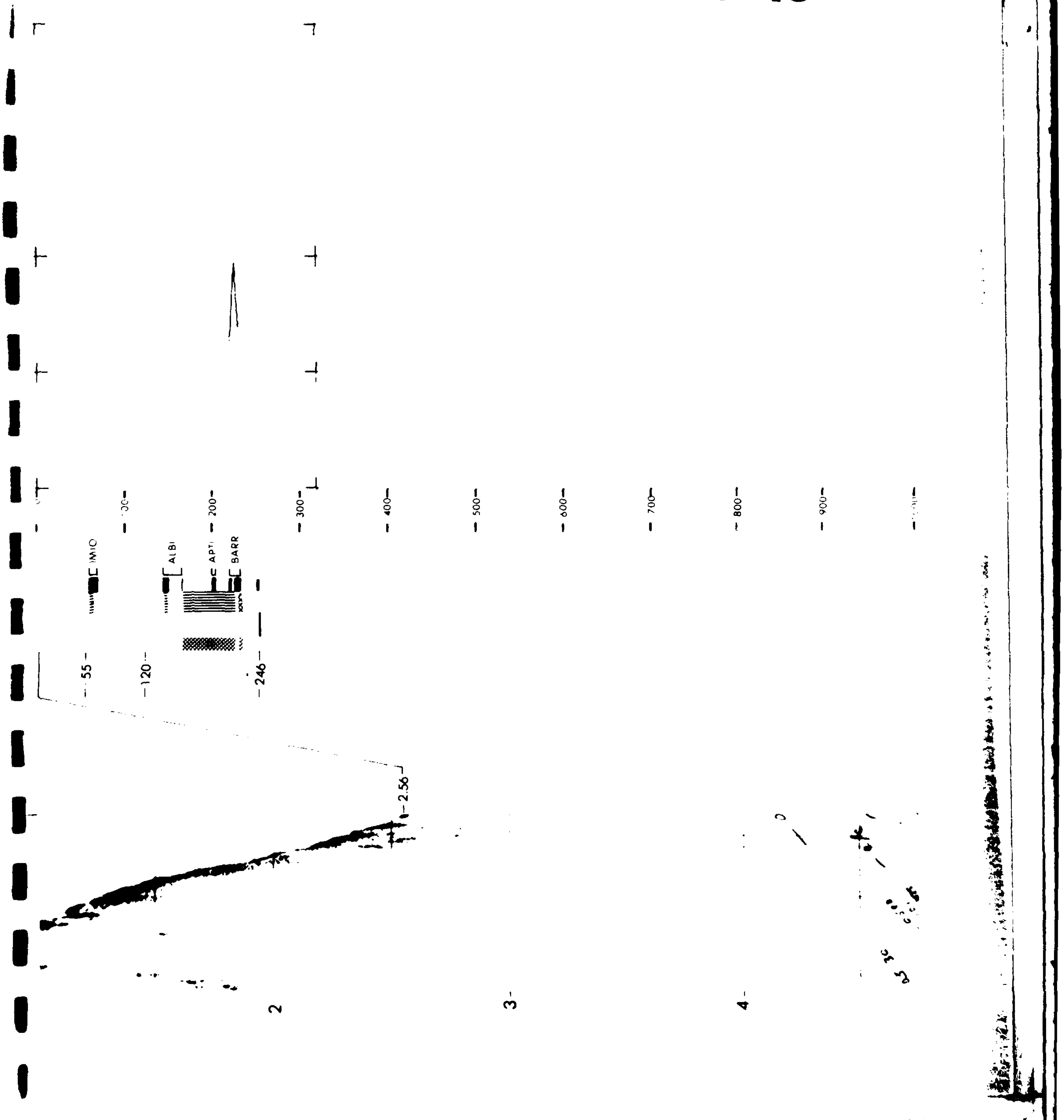
Calcareous sediment, nannofossil rich.

120

SEISMIC REFLECTION RECORD

DEPTH	% CLAY / % SAND	% SiO_2 / % $CaCO_3$	POROSITY (%) / VELOCITY (Km/s)
	100 — 0	100 — 0	90 80 70 60 50 40
	0 — 100	0 — 100	1.5 2.0 2.5 3.0 3.5 4.0

SITE 120 LEG 13



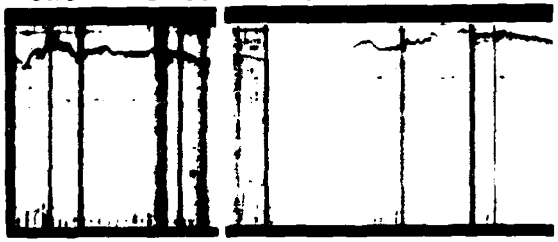
SITE DATA

Position:
Latitude 36°09.5' N
Longitude 4°22.4' W
Date: 06/18/70
Time: 1230Z
Water depth: 1163 meters
Location: Western Alboran Basin

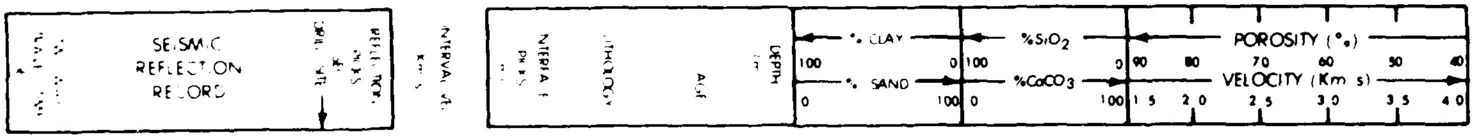
CORE DATA

Penetration:
Drilled-- 706 meters
Cored---- 161 meters
Total---- 867 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 24 cores
46 meters

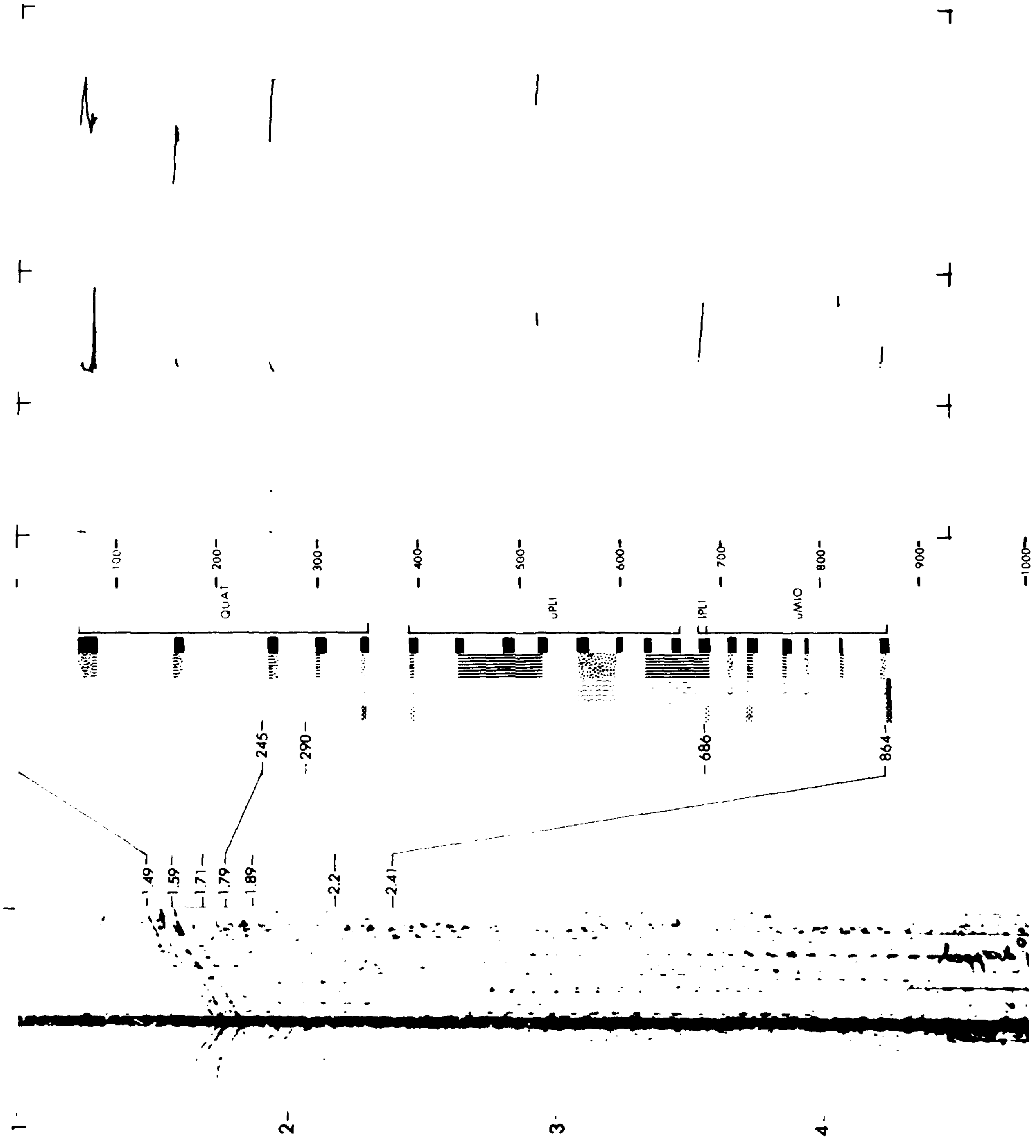
The sedimentary strata at Site 121 in the Western Alboran Basin consist of Pleistocene marls in conformable contact with Pliocene marls, sands and sandstones. In turn, the Pliocene units lie unconformably over and transgress upon a truncated series of Upper Miocene marls, sands and sandstones. A major hiatus comprising the lowermost part of the Lower Pliocene and the uppermost part of the Upper Miocene (Messinian) exists at an angular unconformity observed in seismic reflection profiles. The earliest sediments (Tortonian) are marine marls and contain some gypsum in the form of selenite. These marls rest directly on a marine conglomerate whose components are believed to be fragments of the acoustic basement. Recovered rock units include quartzite, biotite-quartz schist, granodiorite, and cordierite-biotite-feldspar hornfels. The sandstones are cemented by calcite and in part by dolomite. Turbidity currents were major contributors of clastic sediment during the Pliocene. In contrast, the Quaternary strata consists of silty clay whose calcareous component is dominated by nannoplankton. The diversity and relative abundances of the foraminiferal populations indicate climate fluctuations during the Pleistocene. Displacement and reworking of the faunas, particularly the nannoplankton, were noted in the silty clay. A few bedding structures suggest some winnowing by bottom currents. The mean sedimentation rate for the Pliocene and Pleistocene approximates 20 cm/1000 yrs.



121



SITE 121 LEG 13



SITE DATA

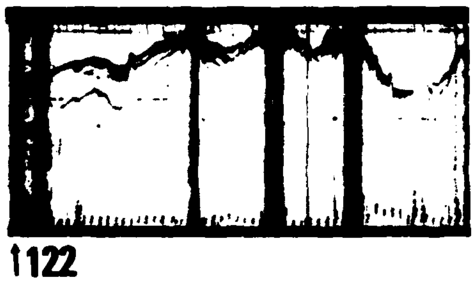
Position:
Latitude 40°26.9' N
Longitude 2°37.5' E
Date: 06/23/70
Time: 0400Z
Water depth: 2146 meters
Location: Valencia Trough

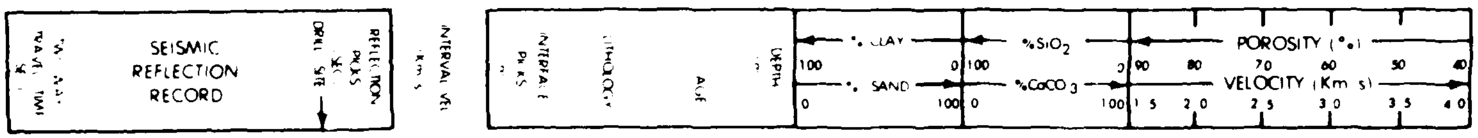
CORE DATA

Penetration:
Drilled-- 132 meters
Cored---- 30 meters
Total---- 162 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 4 cores
5.6 meters

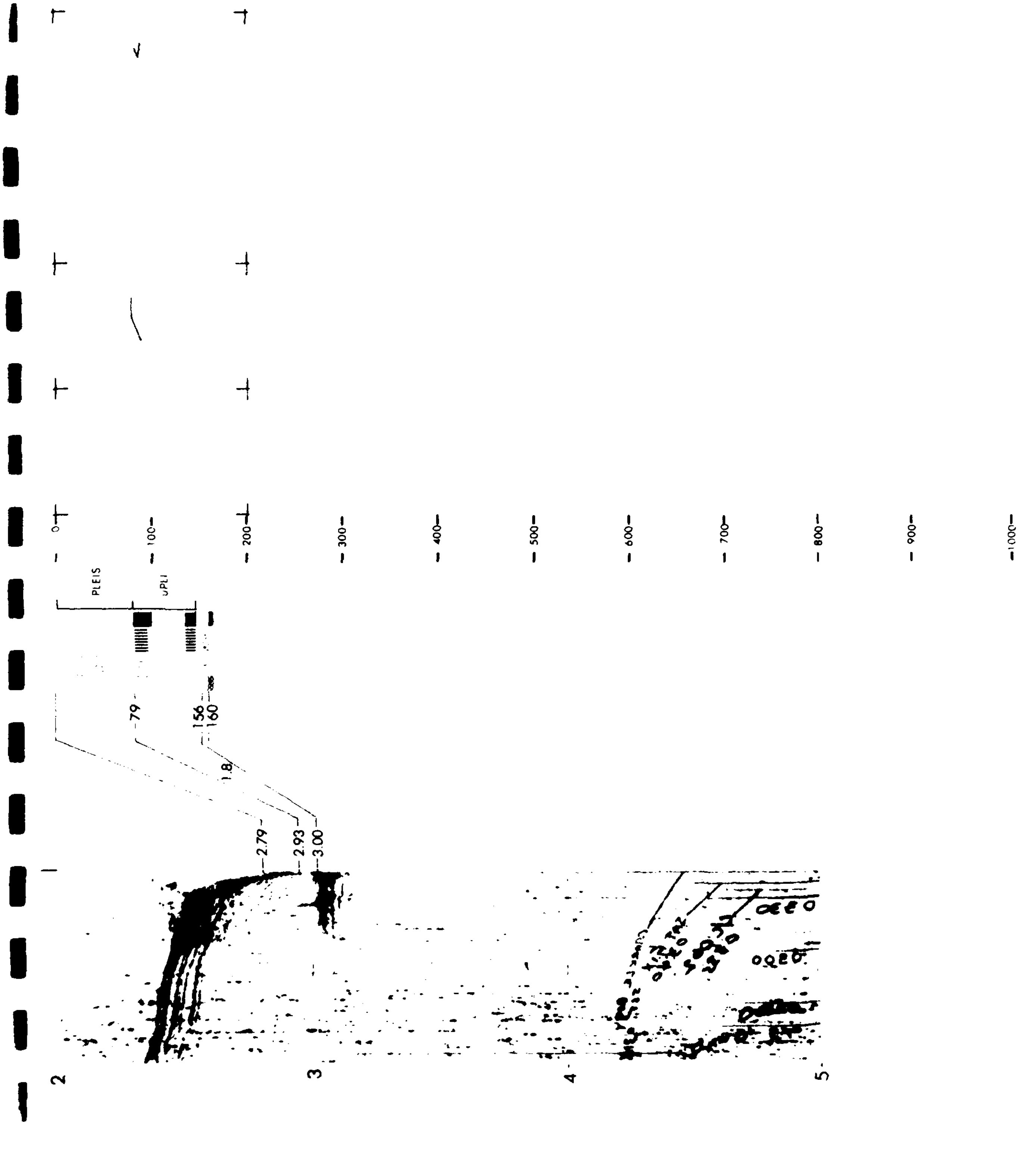
The hole terminated in a massive gravel layer at Horizon M. The gravel contains four components: basalt, limestone, gypsum, and shells of a shallow water fauna. The basalt, limestone, and gypsum are inferred to have been eroded from an Upper Miocene seabed and laid down as a shallow marine transgressive deposit at the close of the Messinian. The deep-sea channel system of the Valencia Trough developed between the Upper Pliocene and Middle Quaternary. A regional stratigraphic unconformity is present in the Upper Pliocene, and the lower most Pliocene is absent above the Messinian evaporites.

Lower Pliocene calcareous sediments nannofossil rich.





SITE 122 LEG 13



SITE DATA

Position:
- Latitude 40°37.8' N
- Longitude 2°50.3' E

Date: 06/25/70
Time: 1030Z
Water depth: 2290 meters
Location: Valencia Basement Ridge

CORE DATA

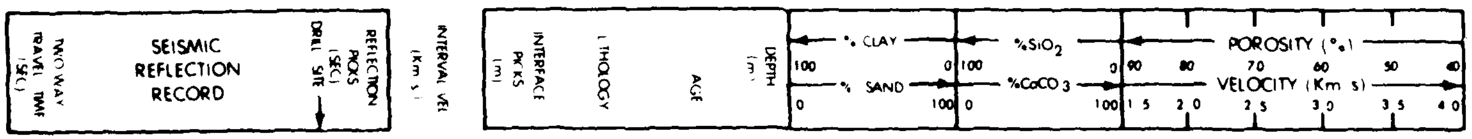
Penetration:
- Drilled-- 327 meters
- Cored---- 71 meters
- Total---- 398 meters

Recovery:
- Basement- 3 cores, 5.6 meters
- Total---- 8 cores, 20 meters

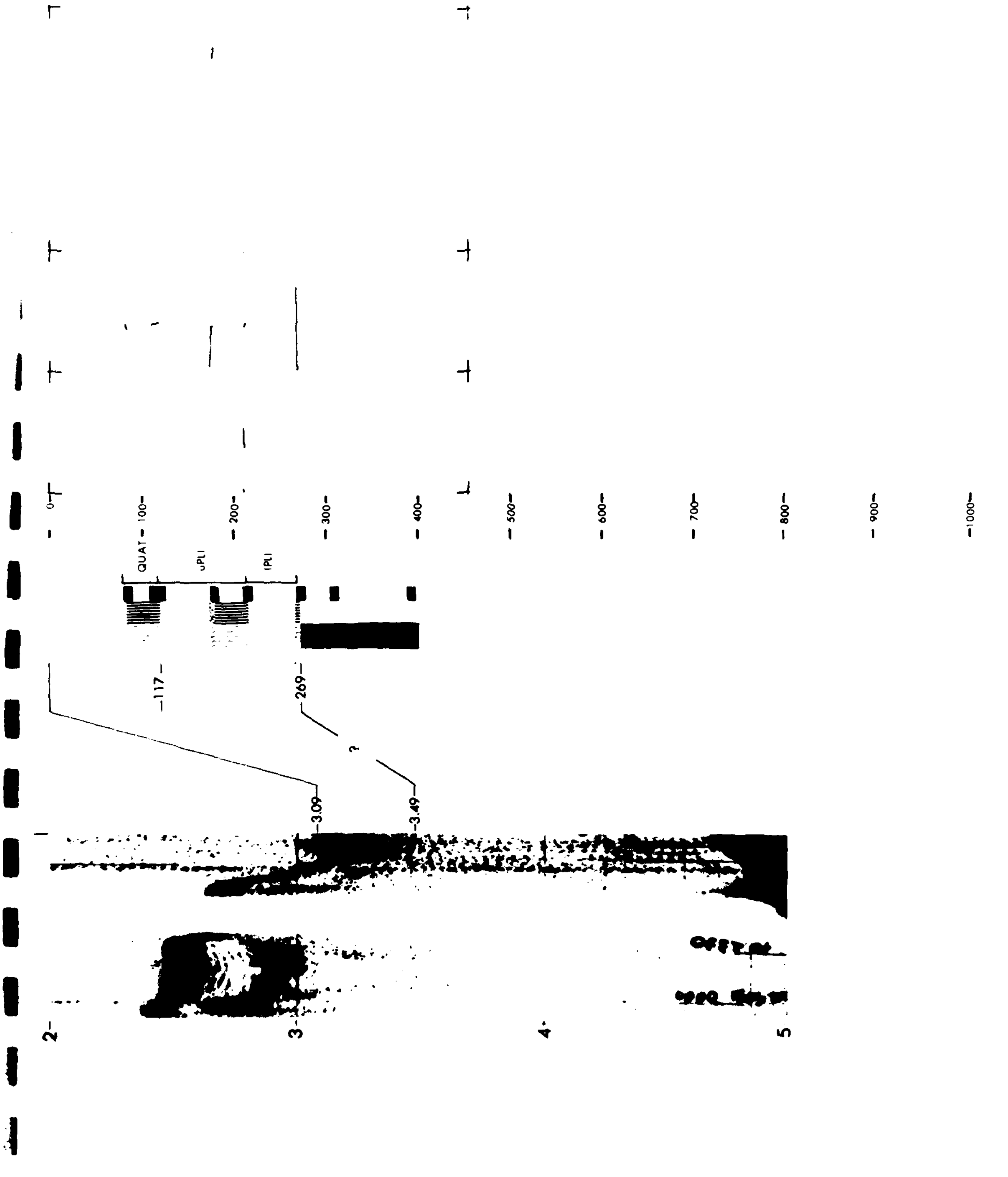
The acoustic basement at Site 123 consists of thick ash deposits. Lower Pliocene graded sands lie along an unconformable contact with the basement which has been radiometrically dated at approximately 21 million years. Current erosion and winnowing on the Pliocene sea floor is indicated by the presence of reworked Miocene faunas and selenite crystals from Messinian evaporites within the younger bedded sand layers and silt laminae. A greater than 1 million year hiatus exists between the Quaternary and the Upper Pliocene. Large, well-rounded pebbles and shallow-water shell debris at the boundary suggest that the hiatus was probably caused by massive seabed erosion, most likely from channeled turbidity currents. The conical configuration of the basement high, the recovery of a pure ash deposit without marine fossils over an interval of more than 100 meters beneath the top of the acoustic bedrock, and the presence of hydrothermal veins in the ash body all suggest that the pyroclastic formation is a flank deposit of a composite volcano. This formation and other volcanic cones of calc-alkaline origin appear to be the features which produce the conspicuous magnetic anomalies observed in the Valencia Trough region of the western Mediterranean.

Calcareous sediments nannofossil rich. One thin layer of detrital, serpentine rich, sediment occurs in upper Pliocene time.

123



SITE 123 LEG 13



SITE DATA

Position:
  Latitude $38^{\circ}52.4'$ N
  Longitude $4^{\circ}59.7'$ E
Date: 06/26/70
Time: 1535Z
Water depth: 2726 meters
Location: Balearic Rise

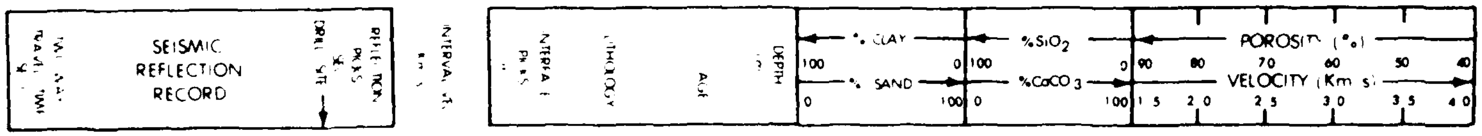
CORE DATA

Penetration:
  Drilled-- 351 meters
  Cored---- 71 meters
  Total---- 422 meters
Recovery:
  Basement- 0 cores
  0 meters
  Total---- 15 cores
  41 meters

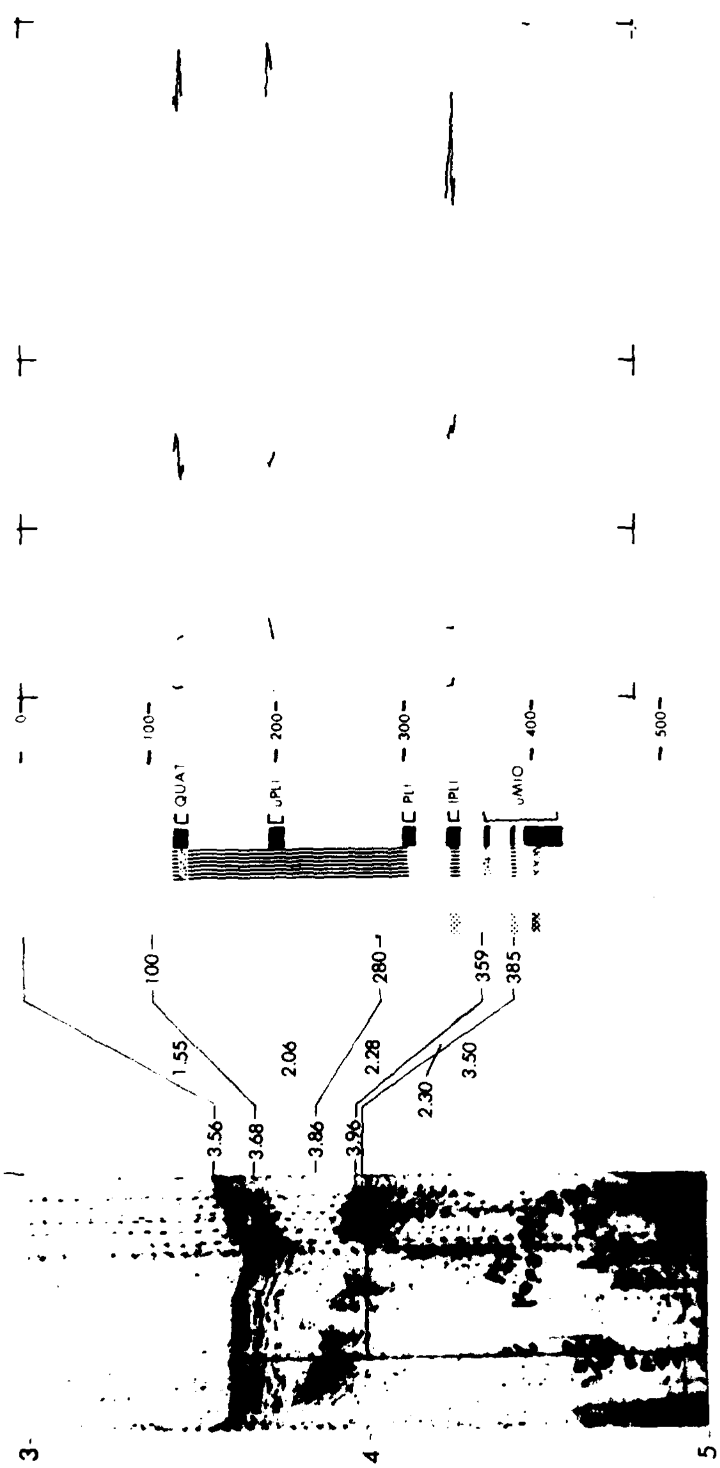
An evaporite formation of Upper Miocene age (Messinian) occurs at the level of the M-Reflectors. The evaporite deposits include barren dolomitic marls interbedded with thin, finely-laminated black layers rich in pyrite and organic matter (carbonaceous), gypsiferous marls with enterolithic fold structures (at certain levels containing dwarfed microfaunas, including both planktonic and shallow water benthic foraminiferal species), laminated algal stramatolites with anhydrite spherules, and nodular anhydrite ranging in displacement development to a massive chickenwire texture. No halite was recovered. Marine sediments of lower Pliocene (but not lowermost) lie along an uncomformable erosional surface. The foraminifera and ostracods in the recovered marl oozes and nannofossil oozes contain deep-water species indicative of a replacement of the Messinian evaporite depositional environment with a bathyal realm. Turbidity current activity, as inferred from graded layers of sands, silts, and marl ooze, becomes dominant in volumetric contribution during the Quaternary and replaces the rhythmically deposited beds of marl ooze (sometimes with laminae of sand and silt, and often with foraminiferal pavements) alternating with nannofossil ooze, variously interpreted as a "contourite" facies.

Calcareous sediments mostly nannofossil rich.

124



SITE 124 LEG 13



SITE DATA

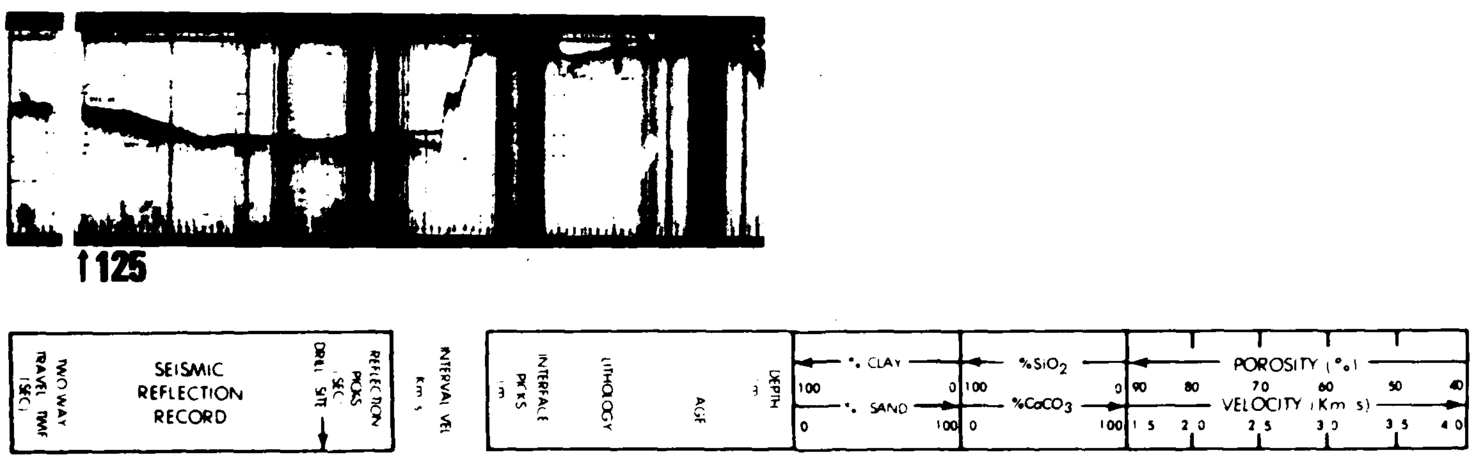
Position:
 Latitude $34^{\circ}37.5'$ N
 Longitude $20^{\circ}25.8'$ E
Date: 09/01/70
Time: 2011Z
Water depth: 2782 meters
Location: Mediterranean Ridge, Ionian Sea

CORE DATA

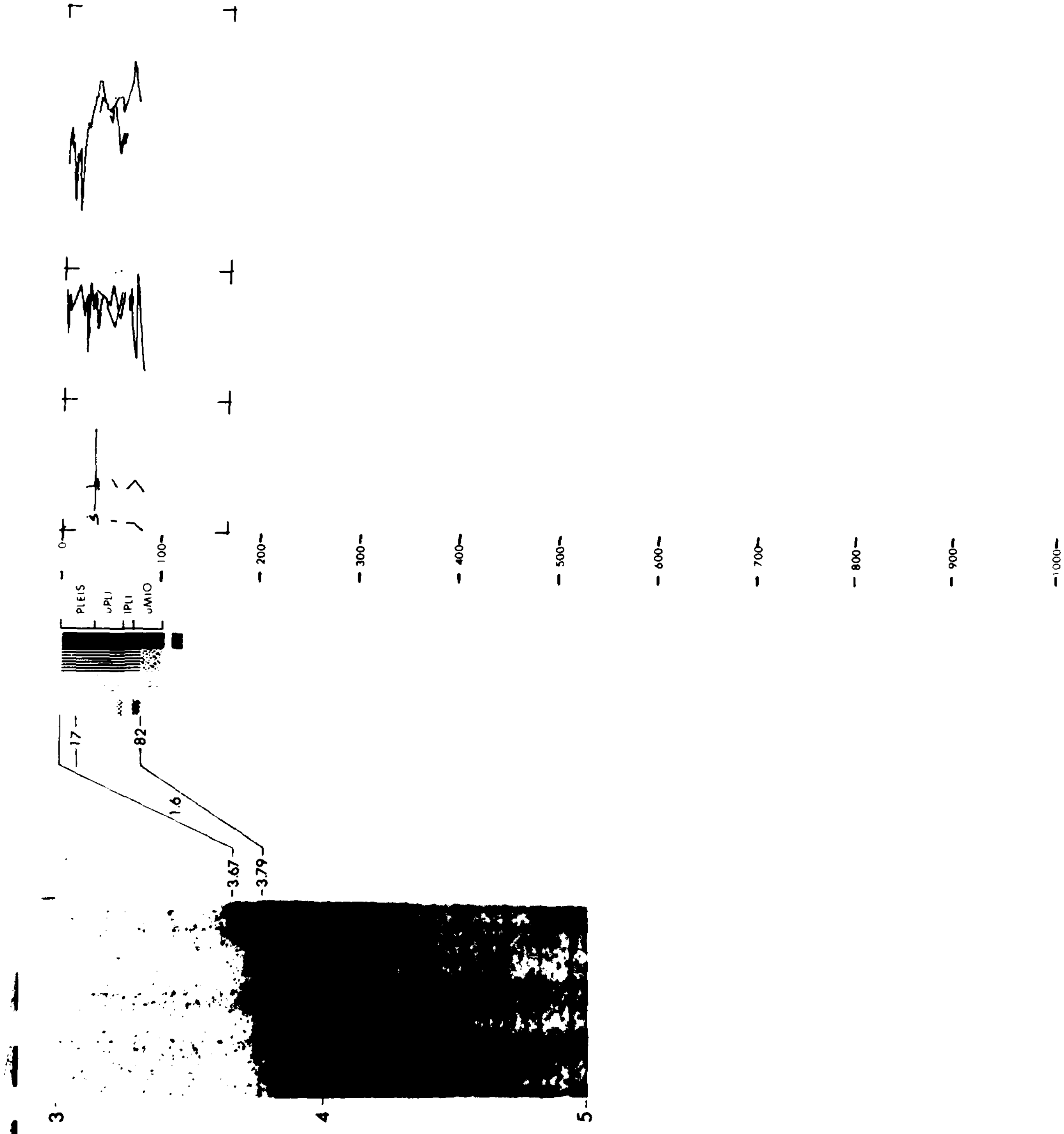
	125	125A	
Penetration:			
Drilled--	50	30	meters
Cored----	48	91	meters
Total----	97	121	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	11	11	cores
	48	18	meters

An excellent section of biogenic, pelagic sediments was obtained. It covered a time span of about 0.4 to 3.8 my BP. A major hiatus exists between the middle of the Lower Pliocene and the top of an evaporite series of Late Miocene (Messinian) age. Layers of dark sapropel indicate intermittent brief stagnations of the Ionian Basin from the Upper Pliocene to the Recent (confirmed by piston coring). Gypsum-chip conglomerates in the evaporites point to depositional cycles during an Upper Miocene salinity crisis involving both sub-aerial erosion and shallow-water, clastic accumulation at the Mediterranean Ridge drill site.

Calcareous sediments nannofossil rich.



SITE 125 LEG 13



SITE DATA

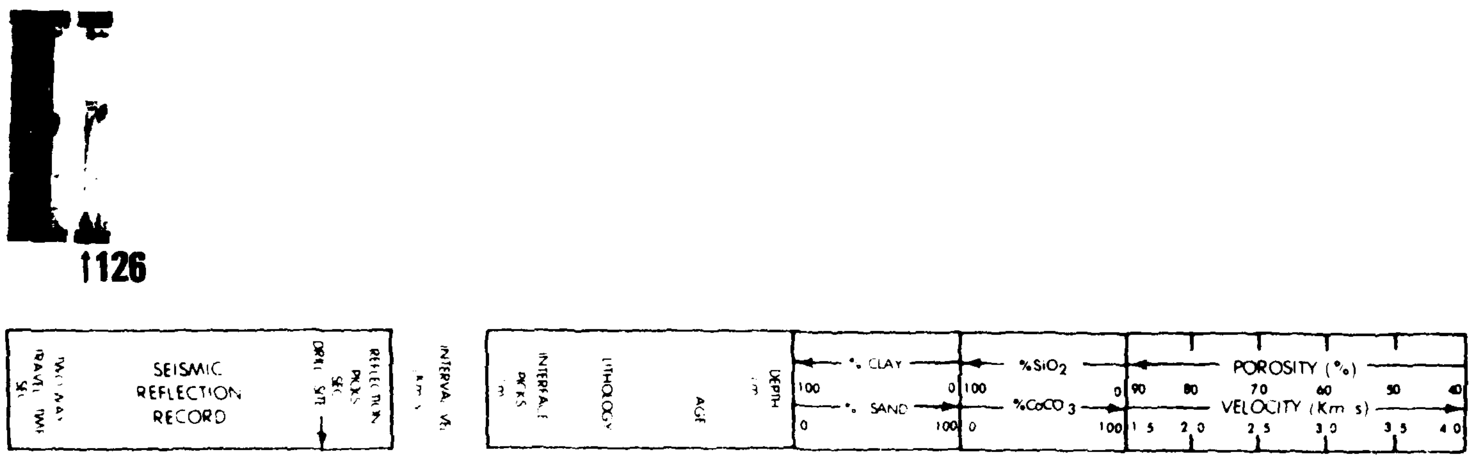
Position:
Latitude 35°09.7' N
Longitude 21°25.6' E
Date: 09/04/70
Time: 1030Z
Water depth: 3730 meters
Location: Cleft in Mediterranean Ridge, Ionian Sea

CORE DATA

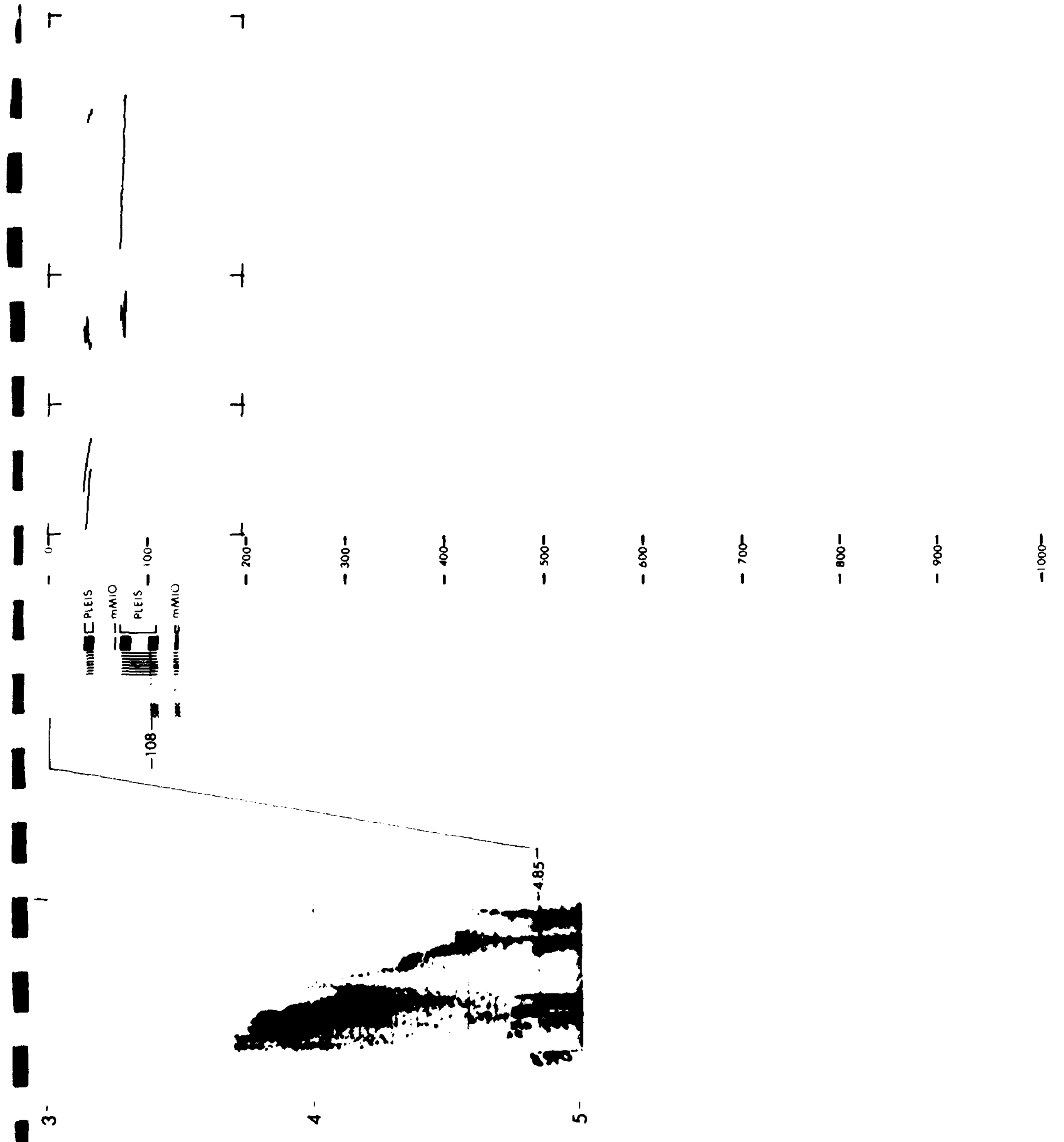
Penetration:	126	126A	
Drilled--	99	65	meters
Cored----	30	1	meters
Total----	129	66	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	6	1	cores
	19	.9	meters

After penetrating a hundred-meter-thick sequence of partly resedimented Quaternary basin fill, the drill string entered massive grayish green shale of Middle Miocene (Serravallian) age. The planktonic fauna indicates an open marine basin of more or less normal salinity prior to the Upper Miocene period of evaporite formation. However, the absence of any kind of benthic life, an abundance of iron sulfide, and occasional fine laminations in this unit indicate anoxic conditions near the sediment-water interface at the time of deposition. Two holes were drilled, and both were terminated in the shale unit when penetration rates in the hard waxy formation dropped to less than one meter per hour.

Calcareous sediments partly nannofossil rich.



SITE 126 LEG 13



SITE DATA

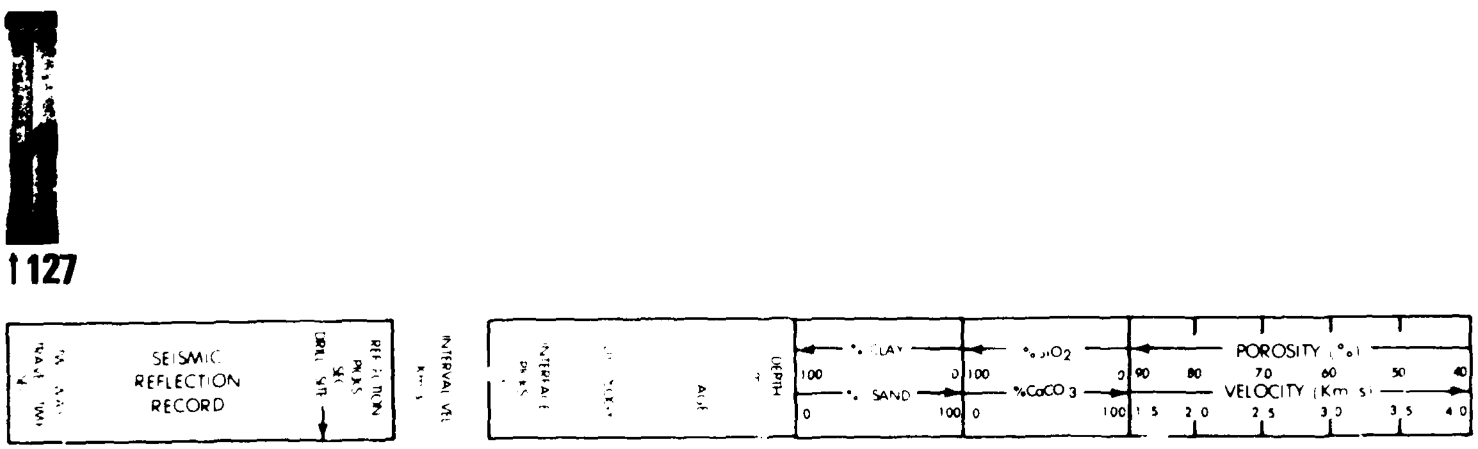
Position:
Latitude 35°43.9' N
Longitude 22°29.8' E
Date: 09/06/70
Time: 1117Z
Water Depth: 4654 meters
Location: Hellenic Trench

CORE DATA

Penetration:	127	127A	127B	
Drilled--	301	49	165	meters
Cored----	136	31	1	meters
Total----	437	80	166	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	19	5	1	cores
	92	23	.5	meters

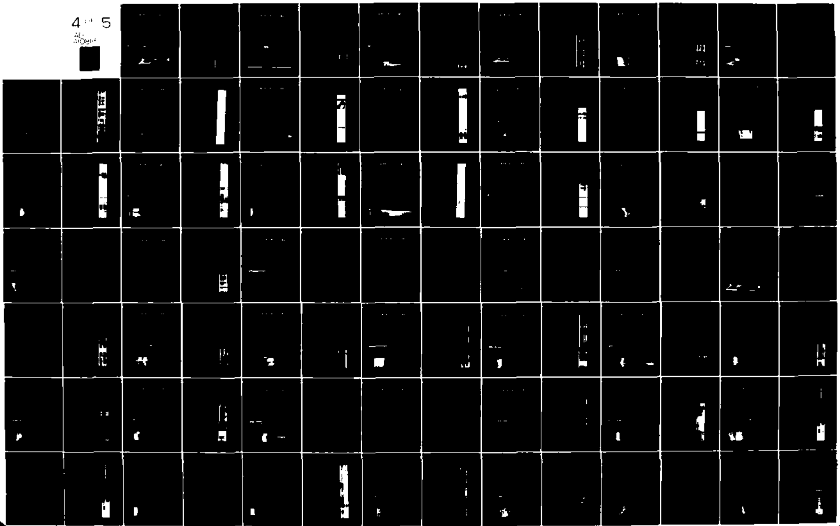
The acoustically stratified sediment fill in the axis of the Hellenic Trench, at least down to a depth of 480 meters below bottom, consists predominantly of current-deposited sands, silts, and marl oozes of Quaternary age. Individual beds have been correlated across the trench plain. The sedimentation process is interpreted to have involved sediment ponding primarily by turbidity currents, although only a very small portion of the components making up any single bed have been reworked from pre-Quaternary strata. The progressive tilting of the trench strata towards the landward wall has occurred at a rate of approximately one degree per million years. Drilling into the inner wall encountered uplifted trench fill and a stratigraphic inversion of Lower Cretaceous limestones above Pliocene pelagic ooze. The contact between the latter two lithostratigraphic units exhibits a cataclastic texture. It is possible that we have penetrated either the talus of an underwater landslide (olistostrome) or a tectonic melange in a zone of underthrusting.

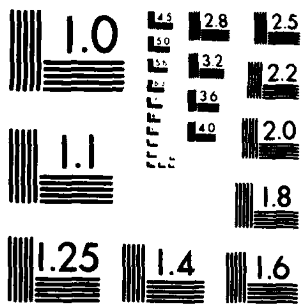
Pleistocene sediments alternating layers of nannofossil rich and foraminifera rich calcareous oozes. Upper Pliocene calcareous partly indurated and nannofossil rich.



AD-A108 115 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 8/10
A SUMMARY OF SELECTED DATA: DSDP LEGS 1-19.(U)
SEP 80 E C SNOW, J E MATTHEWS
UNCLASSIFIED NORDA-25 NL

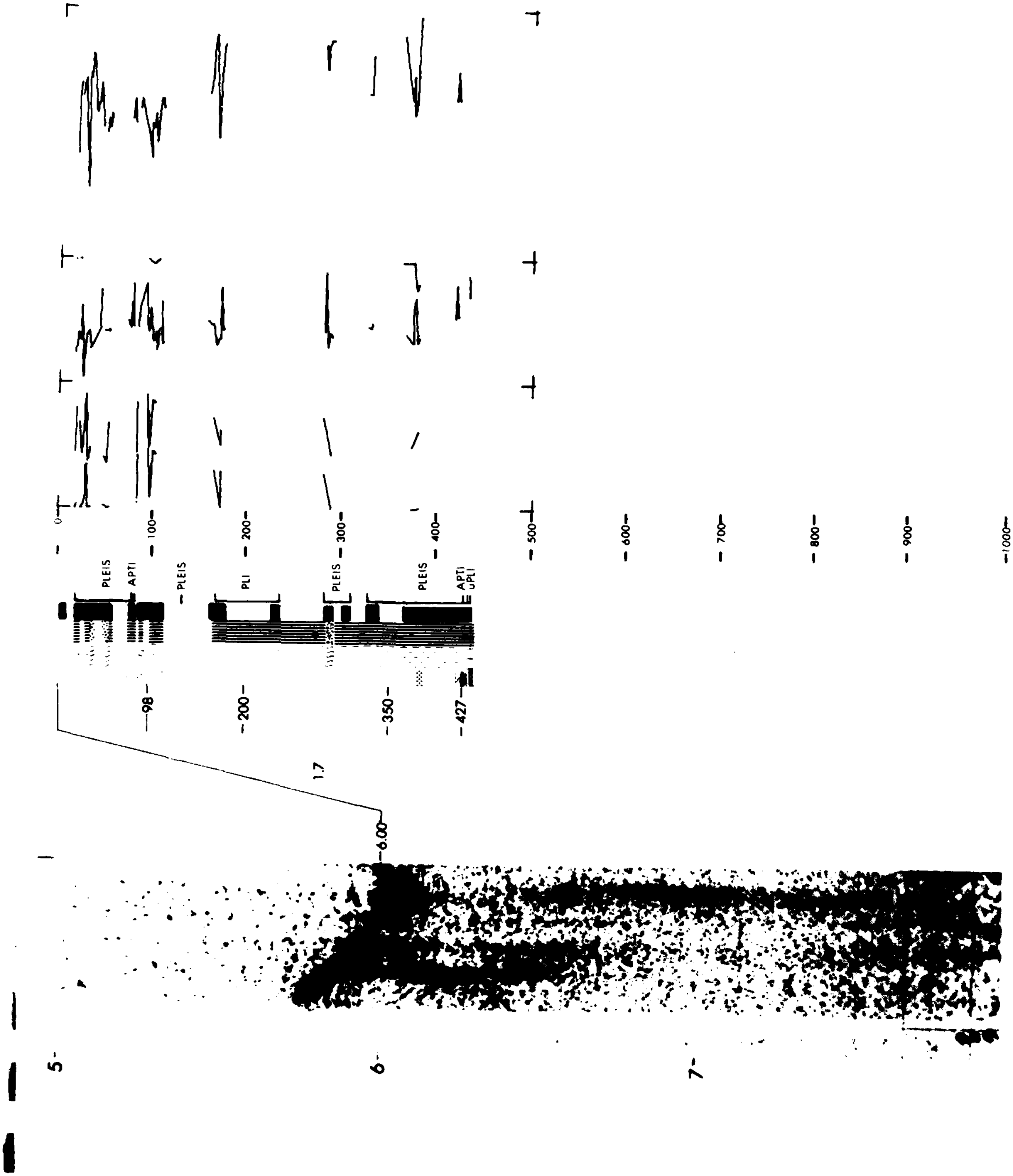
4 of 5





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

SITE 127 LEG 13



SITE DATA

Position:
- Latitude 35° 42.6' N
- Longitude 22° 28.1' E

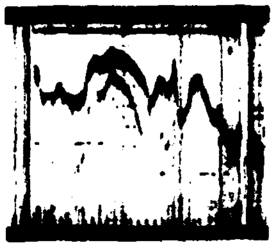
Date: 09/12/70
Time: 1337Z
Water depth: 4640 meters
Location: Hellenic Trench

CORE DATA

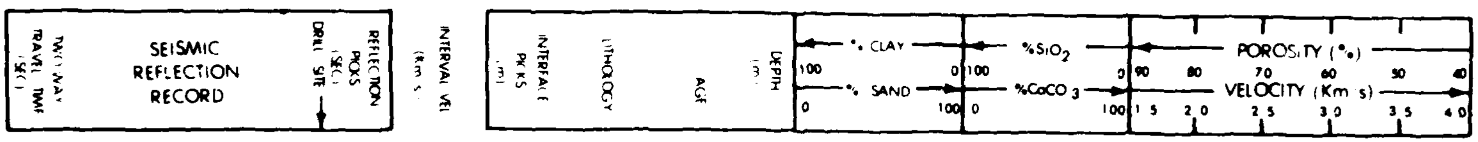
Penetration:
- Drilled-- 390 meters
- Cored---- 91 meters
- Total---- 481 meters

Recovery:
- Basement- 0 cores, 0 meters
- Total---- 11 cores, 74 meters

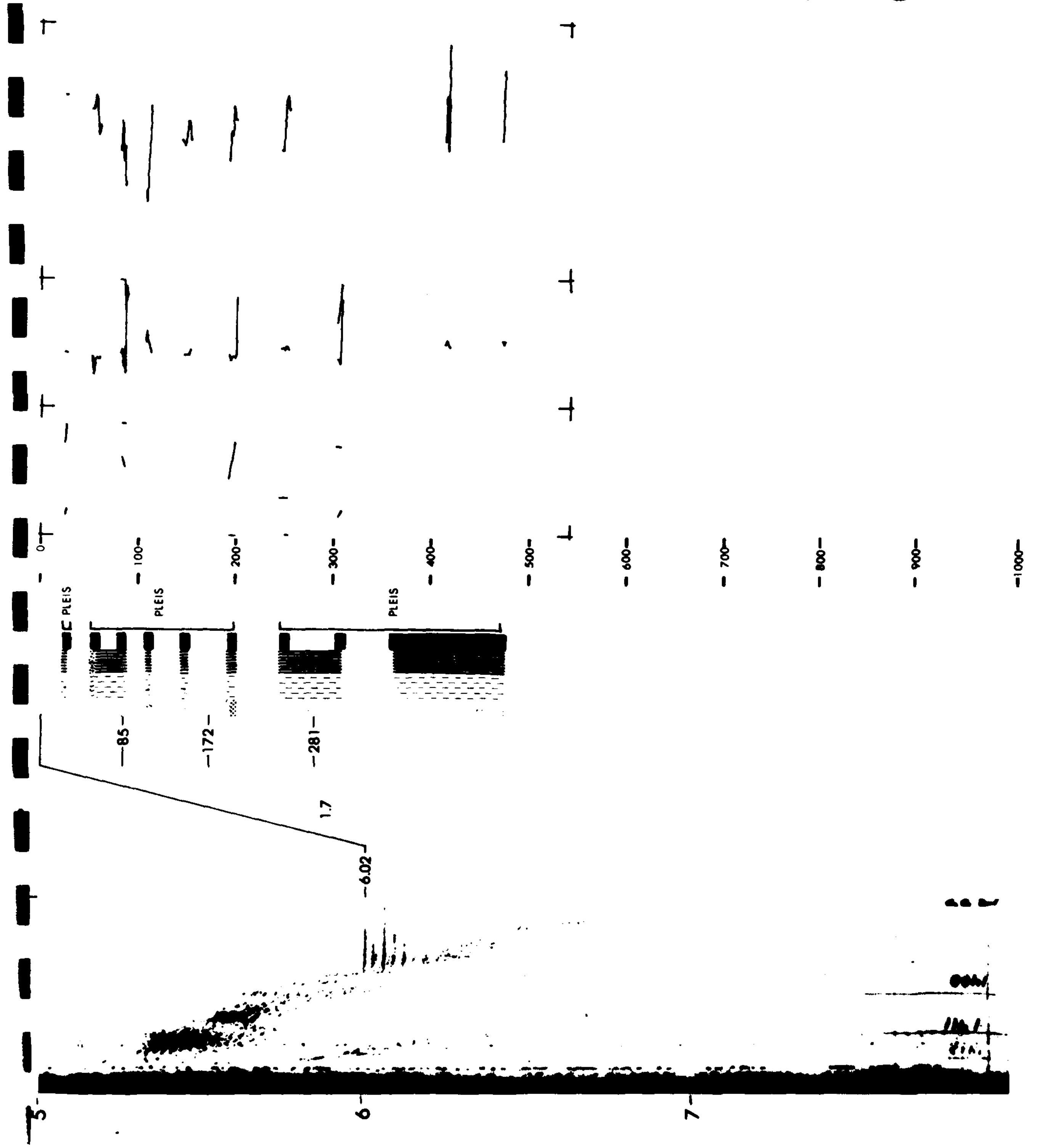
Discussed with Site 127.



128



SITE 128 LEG 13



SITE DATA

Position:
- Latitude 34°21.0' N
- Longitude 27°04.9' E

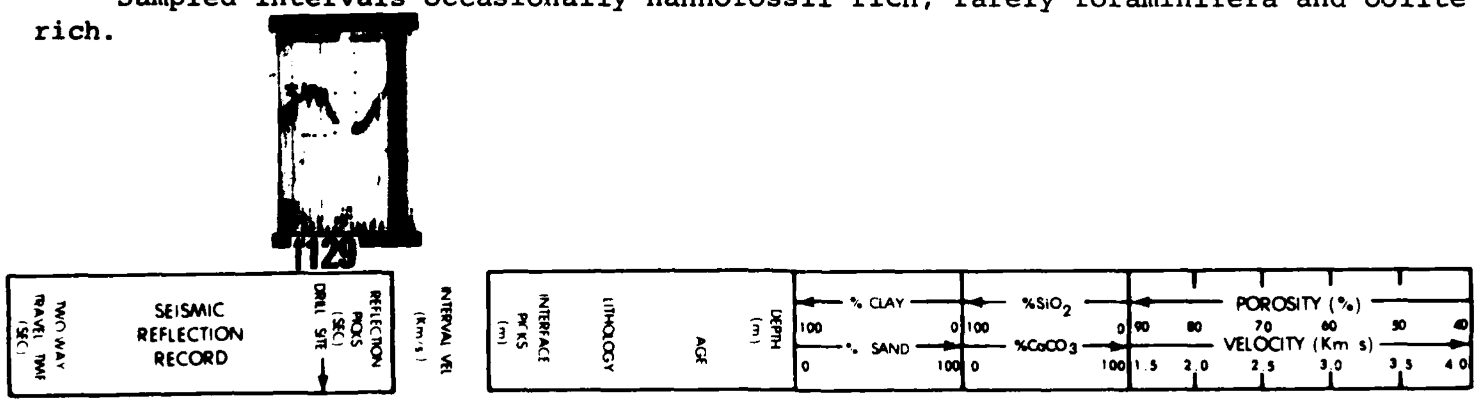
Date: 09/16/70
Time: 0420Z
Water Depth: 3048 meters
Location: Hellenic Trough

CORE DATA

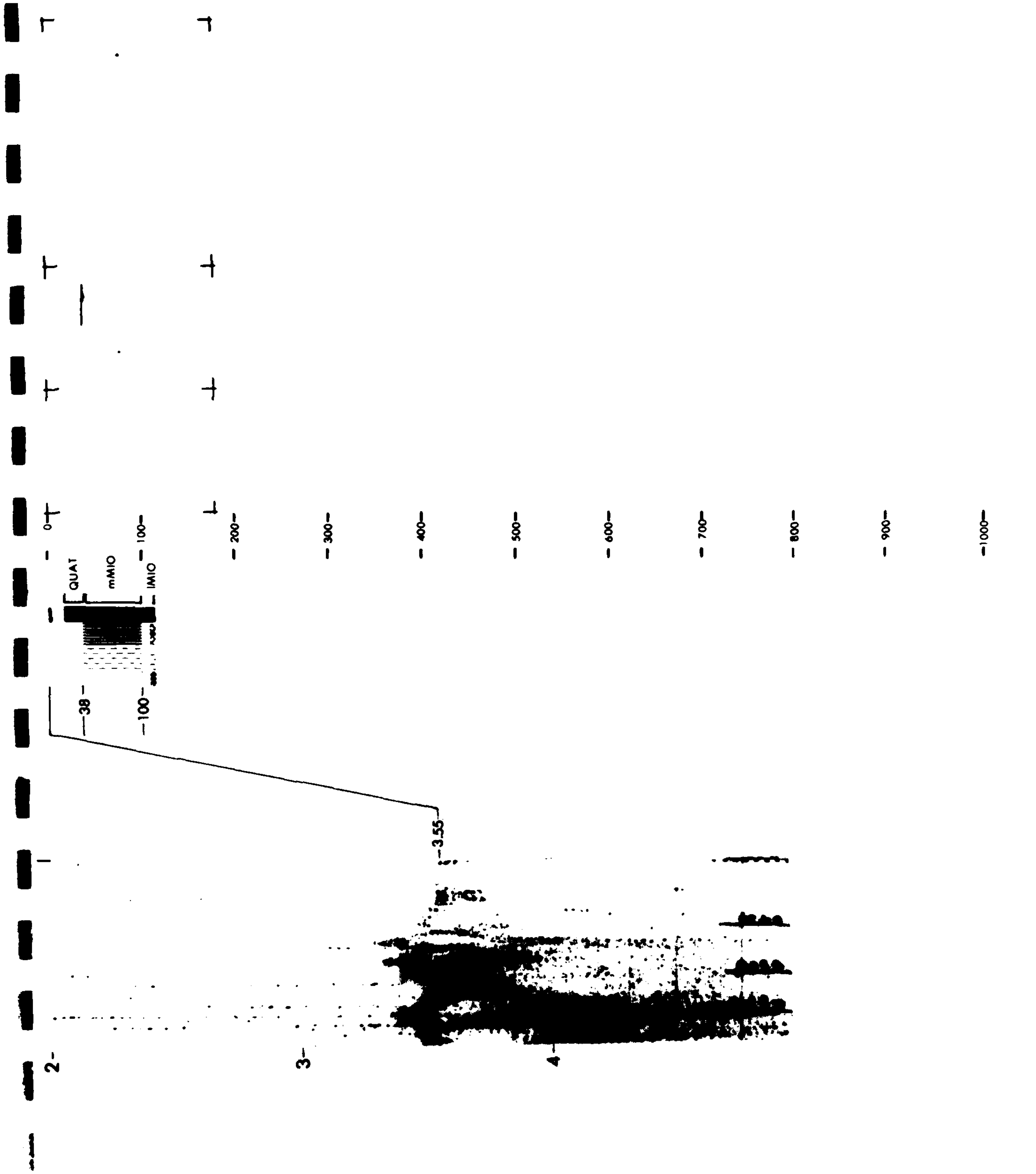
Penetration:	129	129A	129B	
Drilled--	99	68	27	meters
Cored----	13	13	15	meters
Total----	112	81	42	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	4	3	2	cores
	2.8	1.7	1.4	meters

We drilled into a terrain which yielded fossil assemblages in apparent or real abnormal superposition. The anomalies could be attributed to allochthonous deposition and to tectonic disturbances, complicated further by the possibility of some downhole contamination. The detailed geologic structure in the area circumscribed by the three holes is little known. However, the stratigraphic information, interpreted within the regional framework, provided us with very valuable information on the Neogene evolution of the Mediterranean. Cores from Hole 129 proved that this part of the eastern Mediterranean was an open marine basin of pelagic sedimentation in the early Middle Miocene (Langhian). Oceanic circulation was hindered and the basin become stagnant during the late Middle Miocene (Serravallian). Evidence for the Messinian pan-Mediterranean salinity crisis is afforded by the recognition of a brackish-water ostracod fauna in an Upper Miocene dolomitic marl (Hole 129A). Earliest Pliocene Sphaeroidinellopsis microfauna has been identified from a downhole contaminant in Hole 129, and from an allochthonous sediment in Hole 129B, suggesting that the basin was deeply submerged when normal marine waters returned after the crisis. The tectonic movement responsible for the deformation and uplift of the sequence under the trench wall contributed displaced fossils and exotic blocks to olistostromes intercalated in Late Quaternary trench sediments (in Hole 129B).

Sampled intervals occasionally nannofossil rich; rarely foraminifera and oolite rich.



SITE 129 LEG 13



SITE DATA

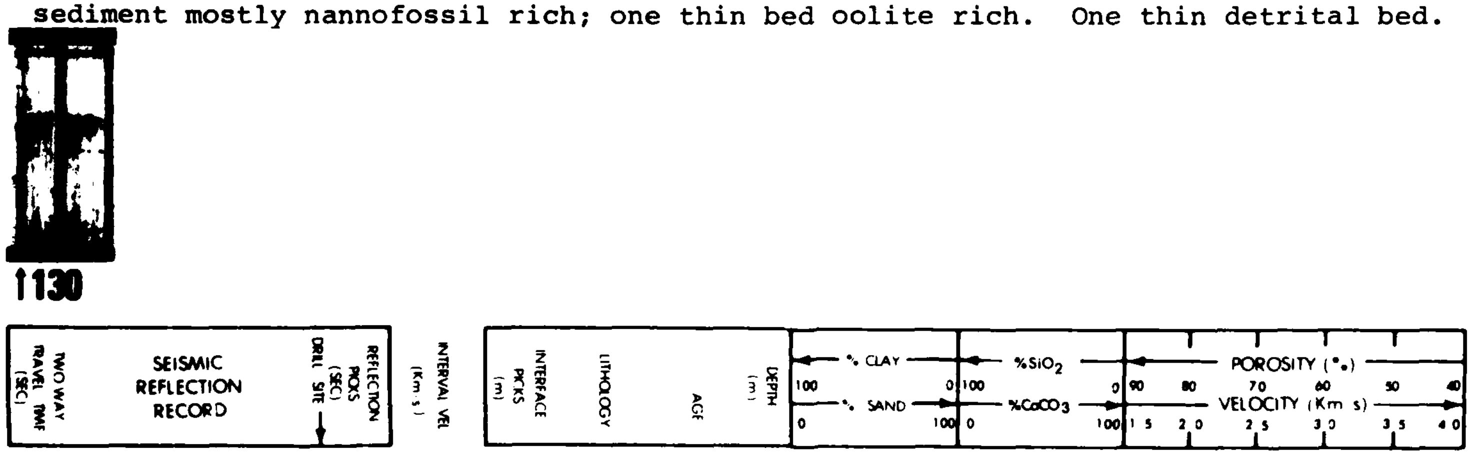
Position:
Latitude 33°36.3' N
Longitude 27°52.0' E
Date: 09/16/70
Time: 0912Z
Water depth: 2979 meters
Location: Mediterranean Ridge

CORE DATA

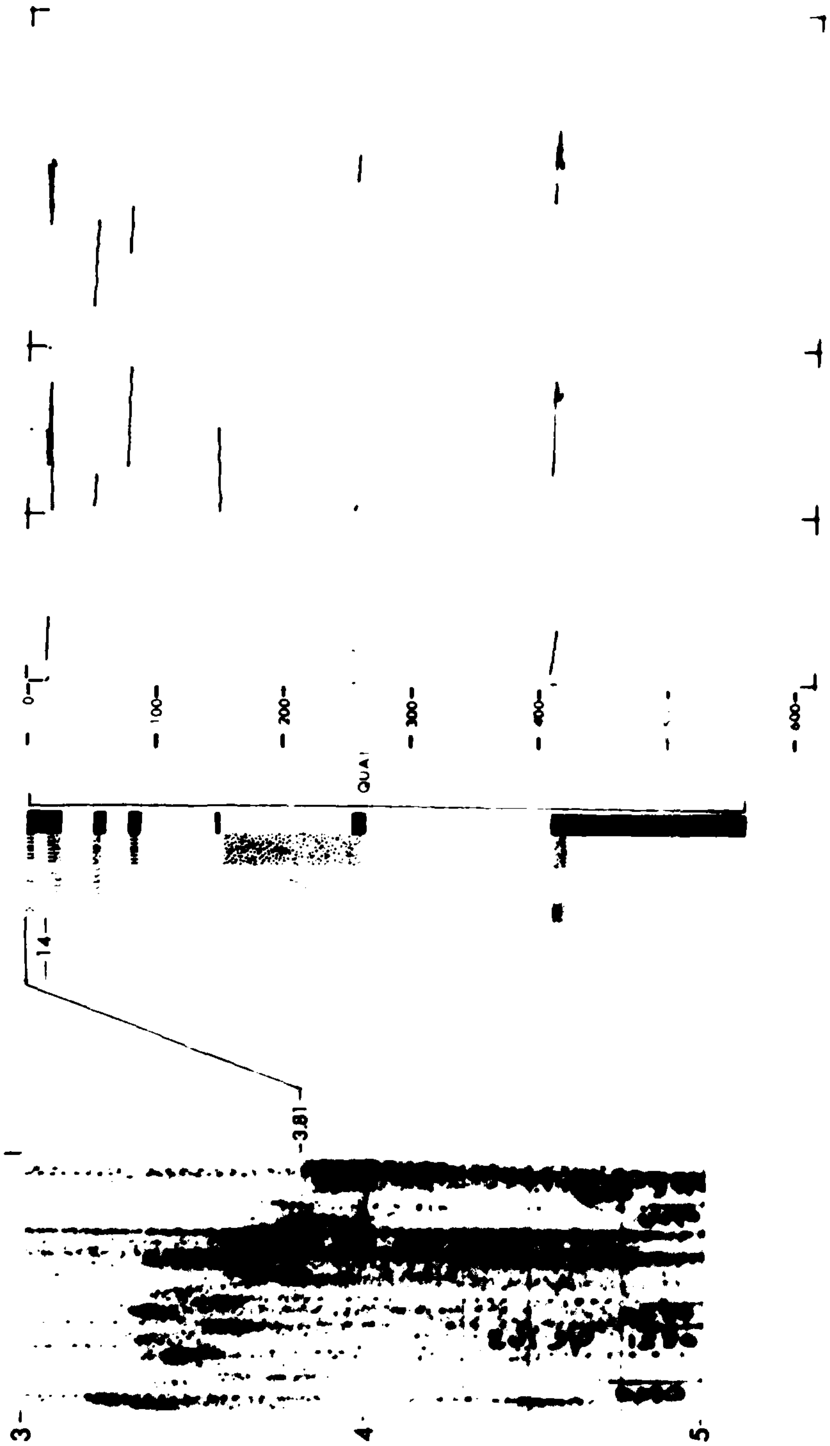
Penetration:	130	130A	
Drilled--	496	11	meters
Cored----	67	0	meters
Total----	563	11	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	7	1	cores
	23	1	meters

Two holes were drilled at Site 130. The first penetrated a thick sequence of terrigenous muds, sands, and sandstones more than 500 meters in thickness, sparsely intercalated with pelagic marl oozes of Quaternary age. Sedimentary textures and primary bedding structures suggest that the terrigenous layers of this formation were deposited for the most part by turbidity currents, and mineralogical investigations of both the fine- and coarse-grained detrital components suggest a North African (Nile River) provenance. The second hole included a core punched directly into the upper sea bed and established that the contemporary ridge surface at the site is blanketed by a layer of pelagic sediment 14.5 meters in thickness. It is concluded that the southern flank of the Mediterranean Ridge here is an uplifted and deformed wedge of basinal sediments, previously deposited on a once extensive abyssal plain seaward of the Nile Cone. Assemblages of foraminifera and dated sequences of sapropelitic mud and volcanic tephra in the superficial layer of pelagic sediment indicate that uplift of the sea bed isolated this part of the ridge from terrigenous deposition of Nile origin sometime around a half million years ago.

Sampled intervals interbedded calcareous and detrital sediments. Calcareous sediment mostly nannofossil rich; one thin bed oolite rich. One thin detrital bed.



SITE 130 LEG 13



SITE DATA

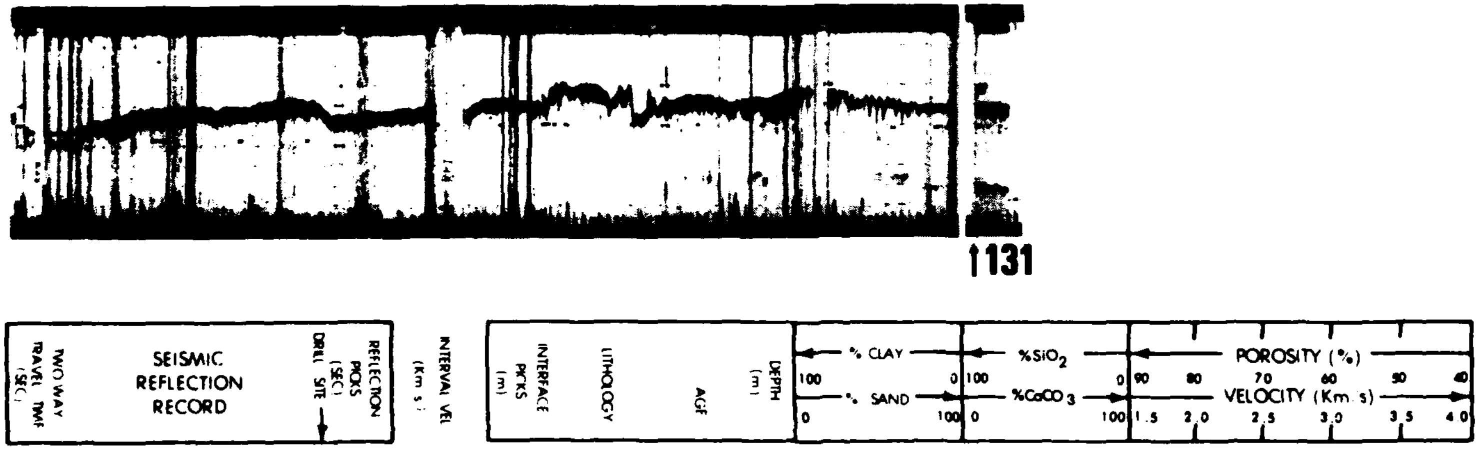
Position:
Latitude 33°06.4' N
Longitude 28° 30.7' E
Date: 09/18/70
Time: 1124Z
Water depth: 3035 meters
Location: Western Nile Cone

CORE DATA

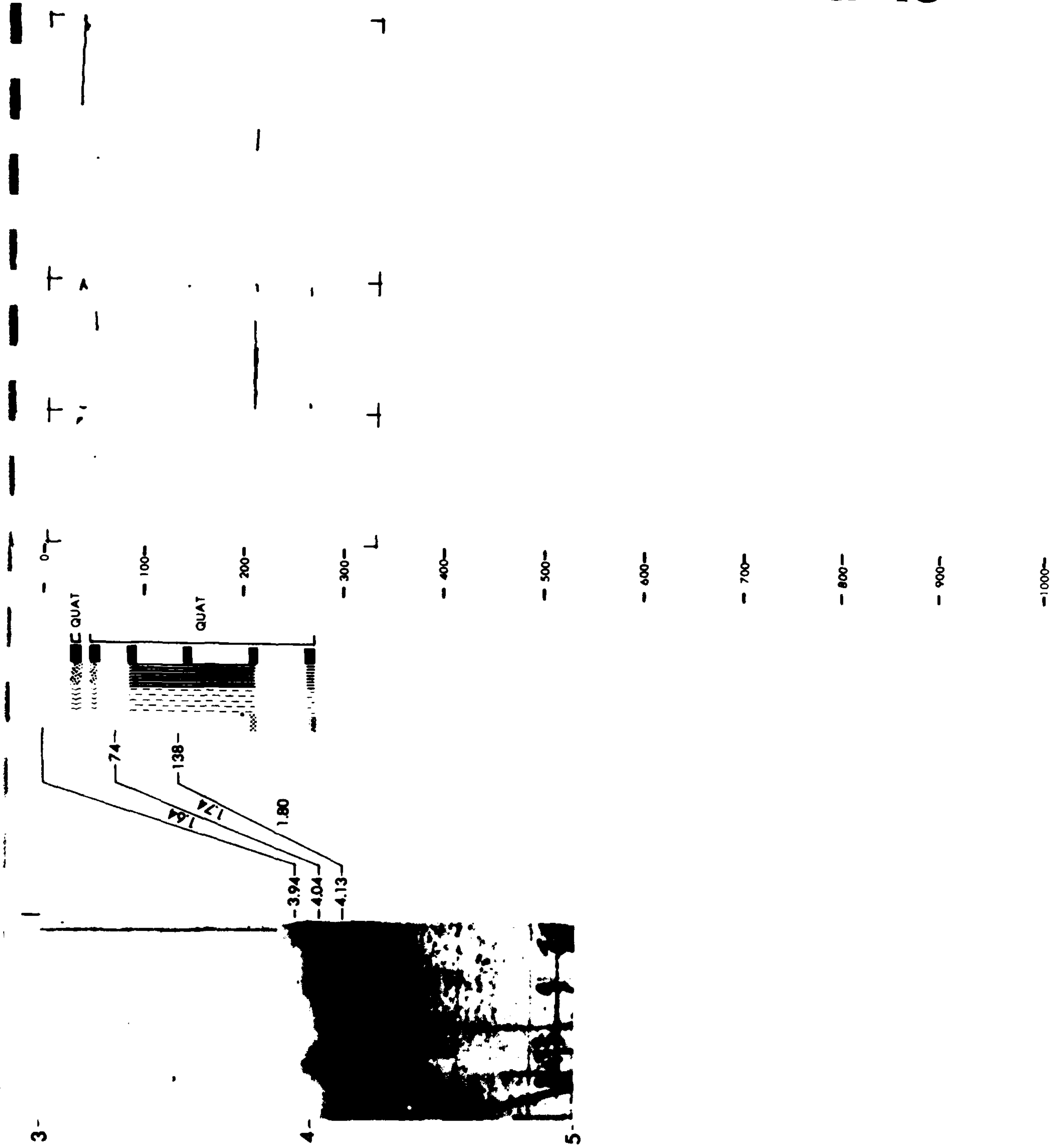
Penetration:	131	131A	
Drilled--	40	227	meters
Cored----	9	45	meters
Total----	49	272	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	5	cores
	8	7.5	meters

Drilling to a depth of 272 meters established that the prominent subsurface reflecting horizon of the Nile Cone area corresponds to an interval comprising lithified detrital sandstones and partly indurated terrigenous clays of Pleistocene age and demonstrates that this horizon is not an extension of Reflector M, and had been previously postulated. The strata penetrated accumulated at a very high rate, possibly exceeding 30cm/10^3y, and they are inferred to have generally been deposited by turbidity currents, except for a few very thin intercalations of calcareous-rich pelagic ooze. The mineral composition of both the fine-grained clay components and the clastic sands is diagnostic of a Nile River source for the vast majority of the terrigenous components.

Calcareous sediment in Quaternary nannofossil rich. Detrital sediments; mica rich.



SITE 131 LEG 13



SITE DATA

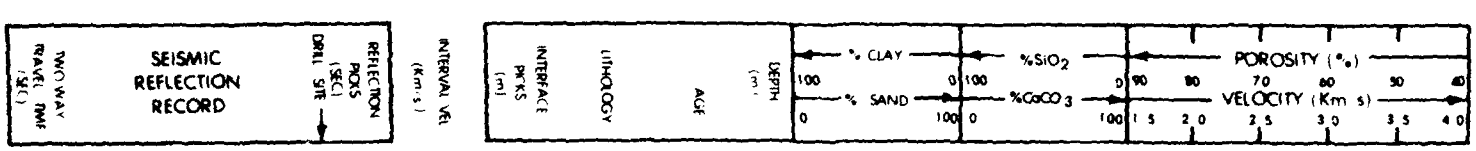
Position:
Latitude 40° 15.7' N
Longitude 11° 26.5' E
Date: 09/24/70
Time: 0817Z
Water depth: 2835 meters
Location: Tyrrhenian Rise

CORE DATA

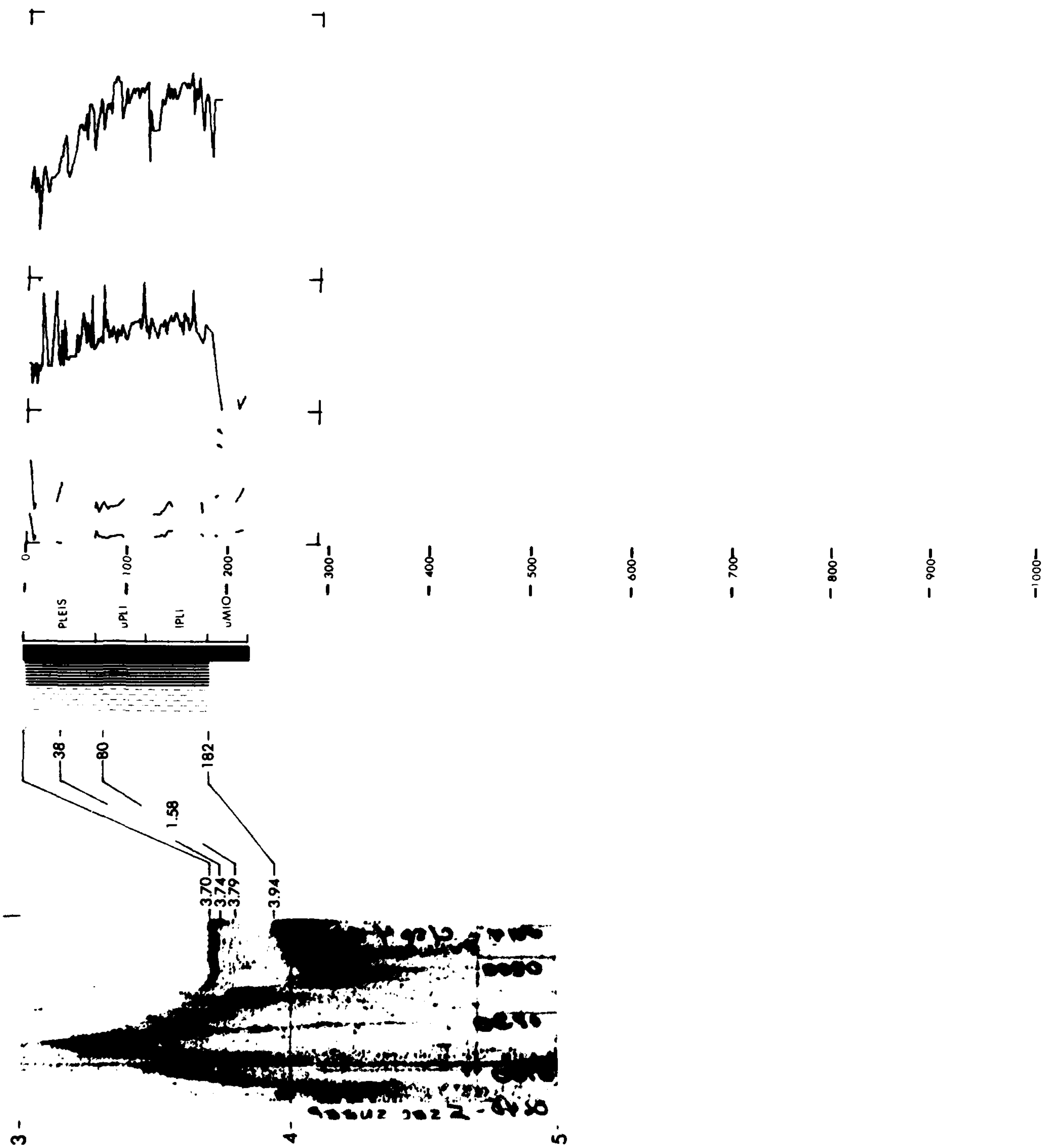
Penetration:
Drilled-- 0 meters
Cored---- 223 meters
Total---- 223 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 27 cores
168 meters

A co. :nuous sequence of Pleistocene and Pliocene fossiliferous pelagic ooze of a deep-wate (bathyal) facies was found directly overlying Late Miocene evaporites which include barren pyritic, dolomitic, and gypsiferous marls, and indurated gypsum rock. The calcium sulfates are heavily recrystallized and partly calcitized, and the recovered gypsum laminites are interpreted to be a diagenetic replacement of former anhydrite stromatolites. The contact between the inferred intertidal and supratidal evaporites and the pelagic ooze is marked by a thin layer of cross-bedded detrital sands with neritic species of benthic foraminifera and dwarfed specimens of a Messinian planktonic fauna. The boundary as found in Core 21 at 188 meters below the sea bed correlates with the uppermost surface of Reflector M. No transitional phase from shallow- to deep-water sedimentation has been found. Thin beds of volcanic ash were found in the Quaternary strata. The Quaternary is also generally accompanied by greater amounts of terrigenous minerals than the older foraminiferal oozes of Pliocene age.

Most sediments nannofossil rich. One sample foraminifera rich.



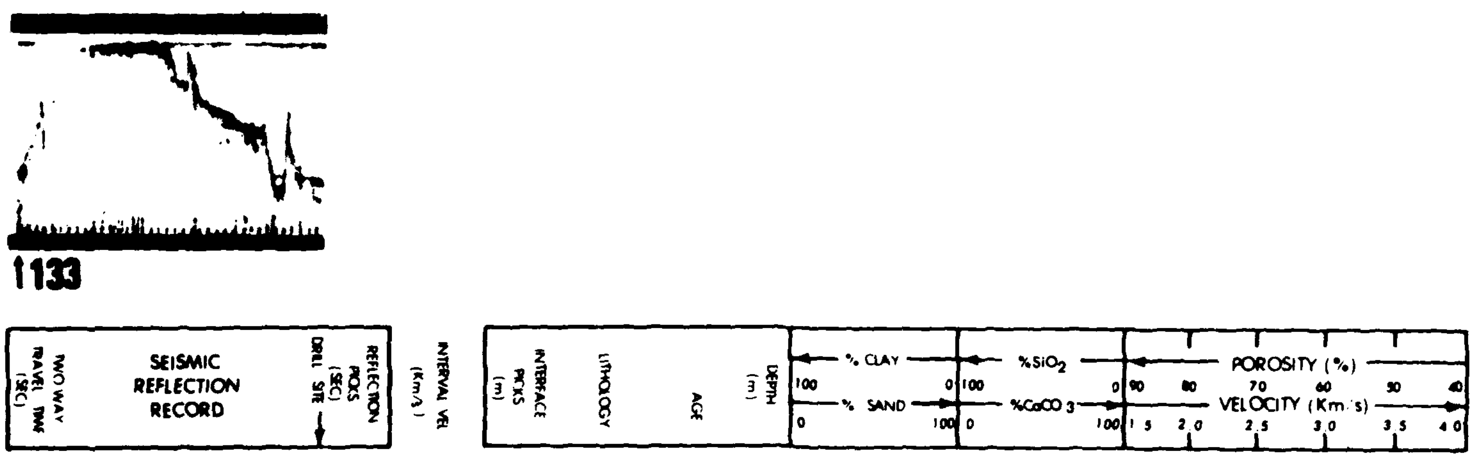
SITE 132 LEG 13



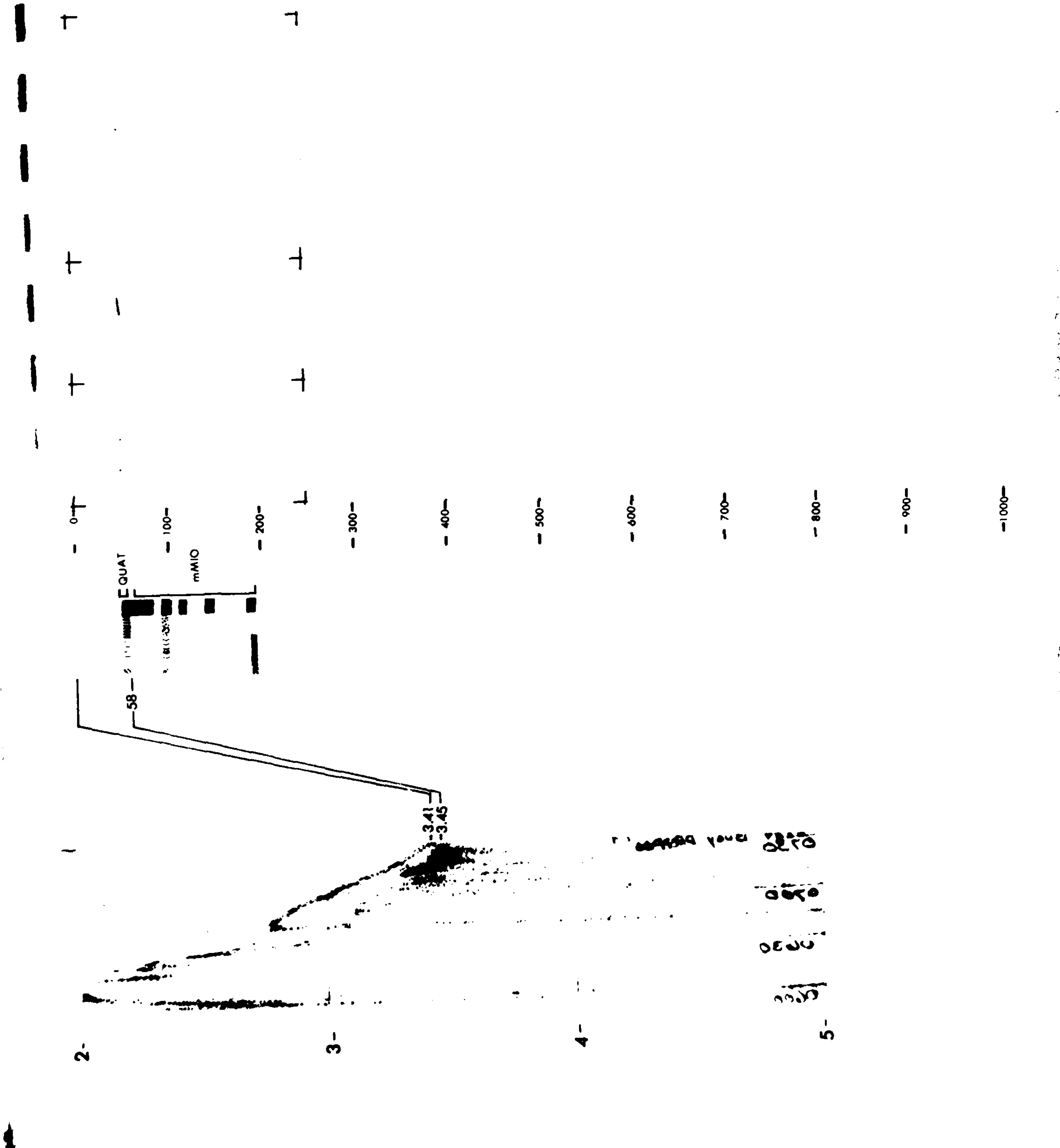
SITE DATA	CORE DATA
Position:	Penetration:
Latitude 39°12.0' N	Drilled-- 124 meters
Longitude 7°20.1' E	Cored---- 68 meters
Date: 09/27/70	Total---- 192 meters
Time: 0730Z	Recovery:
Water depth: 2563 meters	Basement- 1 cores
Location: Balwarc Abyssal	.03 meters
Plain; Sardina coast	Total---- 8 cores
	6 meters

Site 133 was drilled across the nonmagnetic basement ridge from Site 134. The discussion of Site 134 covers both Sites 133 and 134.

One thin layer of detrital, mica rich, sediment occurs in middle Miocene time.



SITE 133 LEG 13



SITE DATA

Position:
Latitude 39°11.7' N
Longitude 7°18.2' E
Date: 10/01/70
Time: 2100Z
Water depth: 2864 meters
Location: Balearc Abyssal Plain; Sardina coast

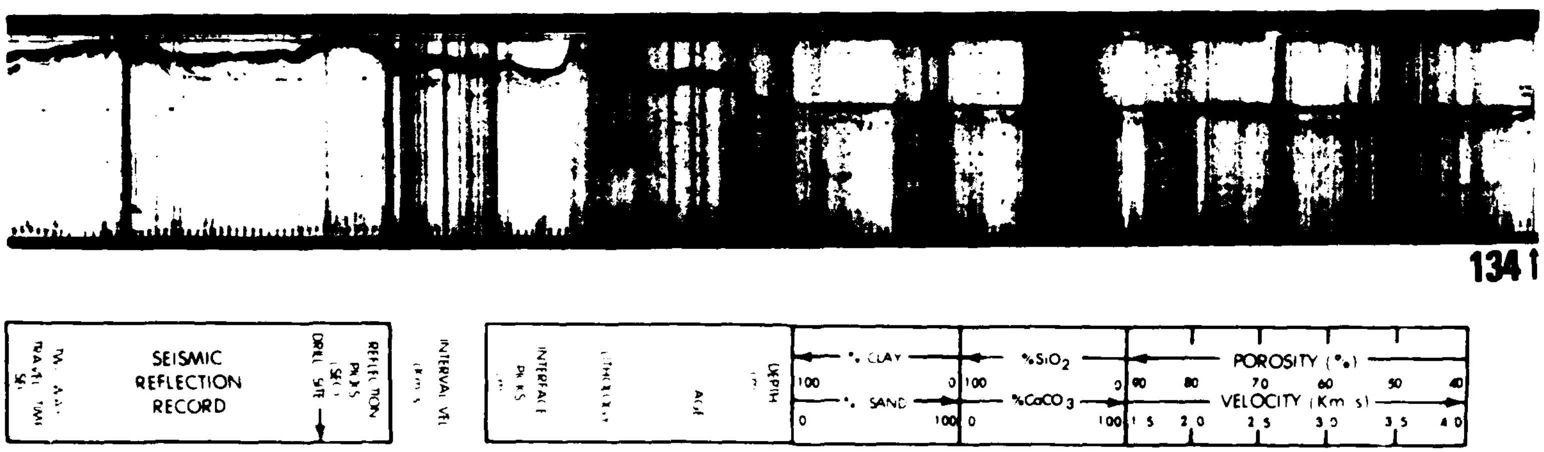
CORE DATA

Penetration:	134	134A	134B	134C	134D	134E	
Drilled--	291	36	67	131	199	206	meters
Cored----	73	14	5	0	15	16	meters
Total----	364	50	72	131	214	222	meters
Recovery:							
Basement-	0	2	1	1	1	3	cores
	0	.04	.2	.03	.3	.3	meters
Total----	10	2	1	1	3	3	cores
	23	1.8	.2	.03	1.3	.6	meters

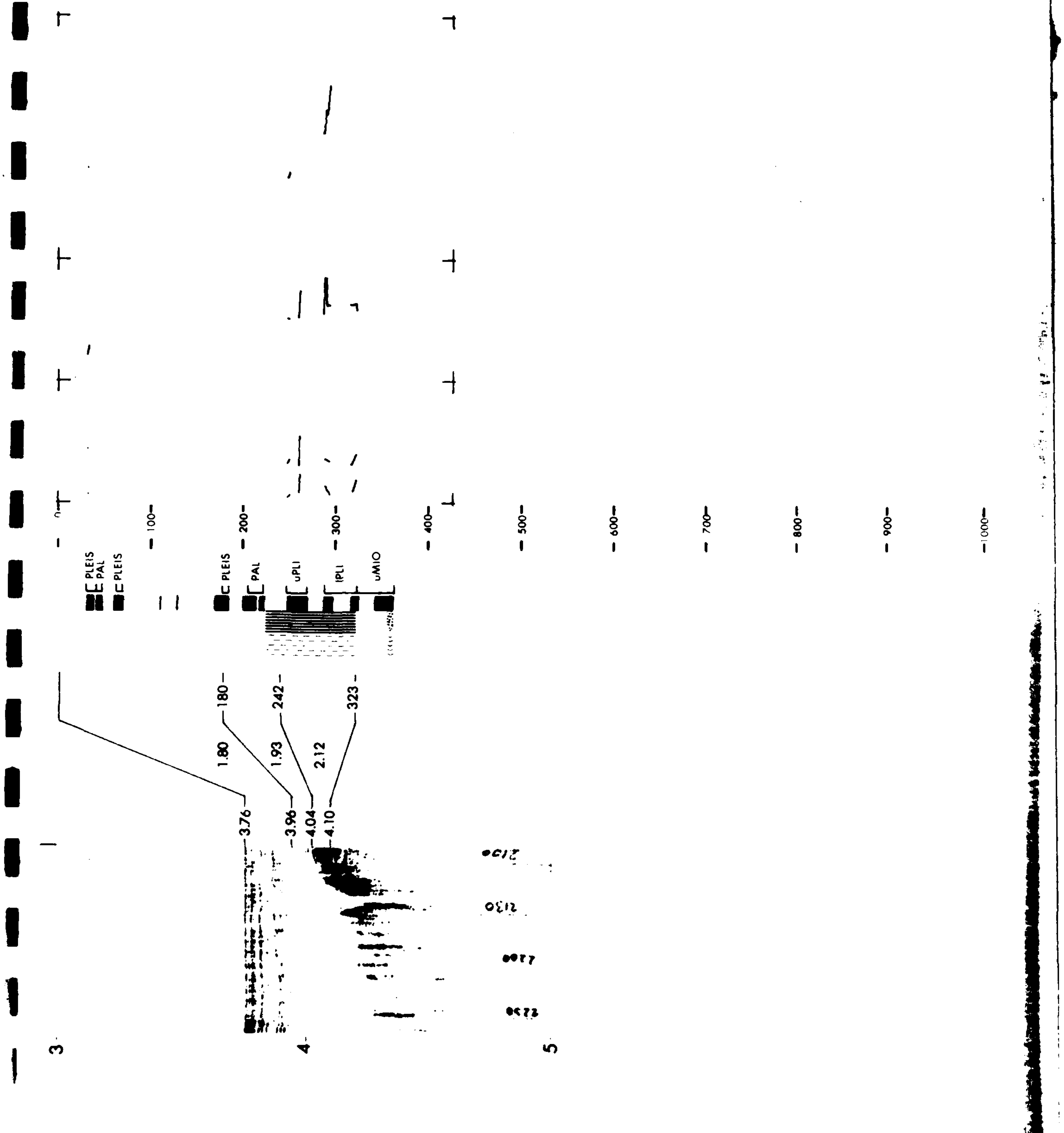
Metamorphic rocks were sampled from the nonmagnetic basement ridge. Horizon M corresponds to the top of the late Miocene Mediterranean evaporite. The facies represented on the shallower landward flank of the basement ridge is terrestrial. It includes sequences of poorly bedded variegated silts and shales, believed to be alluvial deposits. The evaporite facies recovered from beneath the abyssal plain consists of playa salts with an interbed of fossiliferous marl containing significant quanities of gasoline-range light hydrocarbons. Evidence suggests shallow water origin for the salts. The margin of the abyssal plain where Horizon M onlaps the basement ridge is characterized by nodular gypsum and dolomitic silts of the sabkha facies.

Stratigraphic gaps and angular unconformities are present in the overlying marine calcareous oozes of Pliocene and Pleistocene age. The Miocene/Pliocene and Pliocene/Pleistocene boundaries are represented by discontinuities; the latter one recorded in a thin mineralized iron and maganese crust reflecting a period of nondeposition estimated as approximatly one millon years.

Calcareous Pliocene sediments, nannofossil rich.



SITE 134 LEG 13



SITE DATA

Position:
Latitude 35°20.8' N
Longitude 10°25.7' W
Date: 10/09/70
Time: 2400Z
Water depth: 4152 meters
Location: Horseshoe Abyssal Plain

CORE DATA

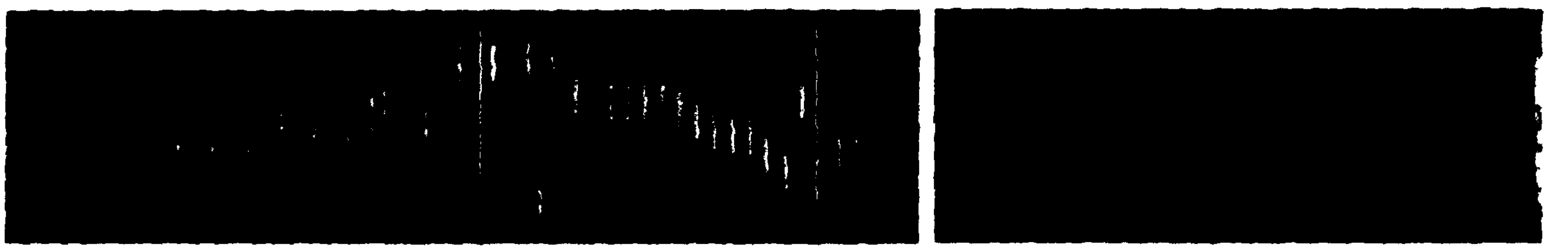
Penetration:
Drilled-- 632 meters
Cored---- 57 meters
Total---- 689 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 9 cores
25 meters

The top unit, 325 meters thick, is comprised of nannoplankton chalk ooze of Pleistocene, Pliocene, and Miocene ages. Below this, there are 364 meters of mostly terrigenous sediments with some silicified intervals and marl or limestone at the base which range in age from Early Eocene to Early Aptian. It is not possible to reasonably estimate the thickness of individual lithologic units within this lower interval.

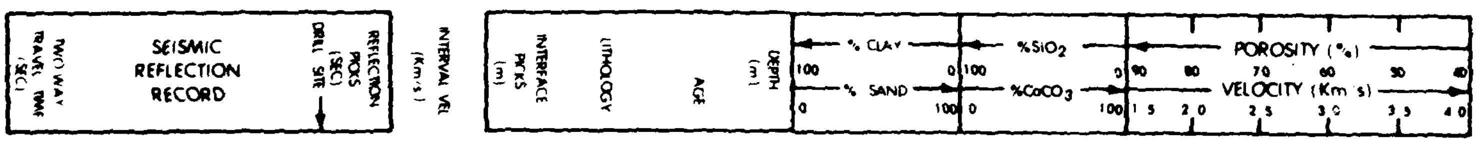
A prominent reflecting horizon at 0.4 second can be traced from beneath the abyssal plain on to the topographic high. In the drilled section this corresponds to a major unconformity which marks the abrupt change from terrigenous to pelagic sedimentation that occurred following post-early Eocene and pre-late Oligocene uplift and faulting.

An estimated 350+ meters of sediment are present between the lowest sample obtained and oceanic basement.

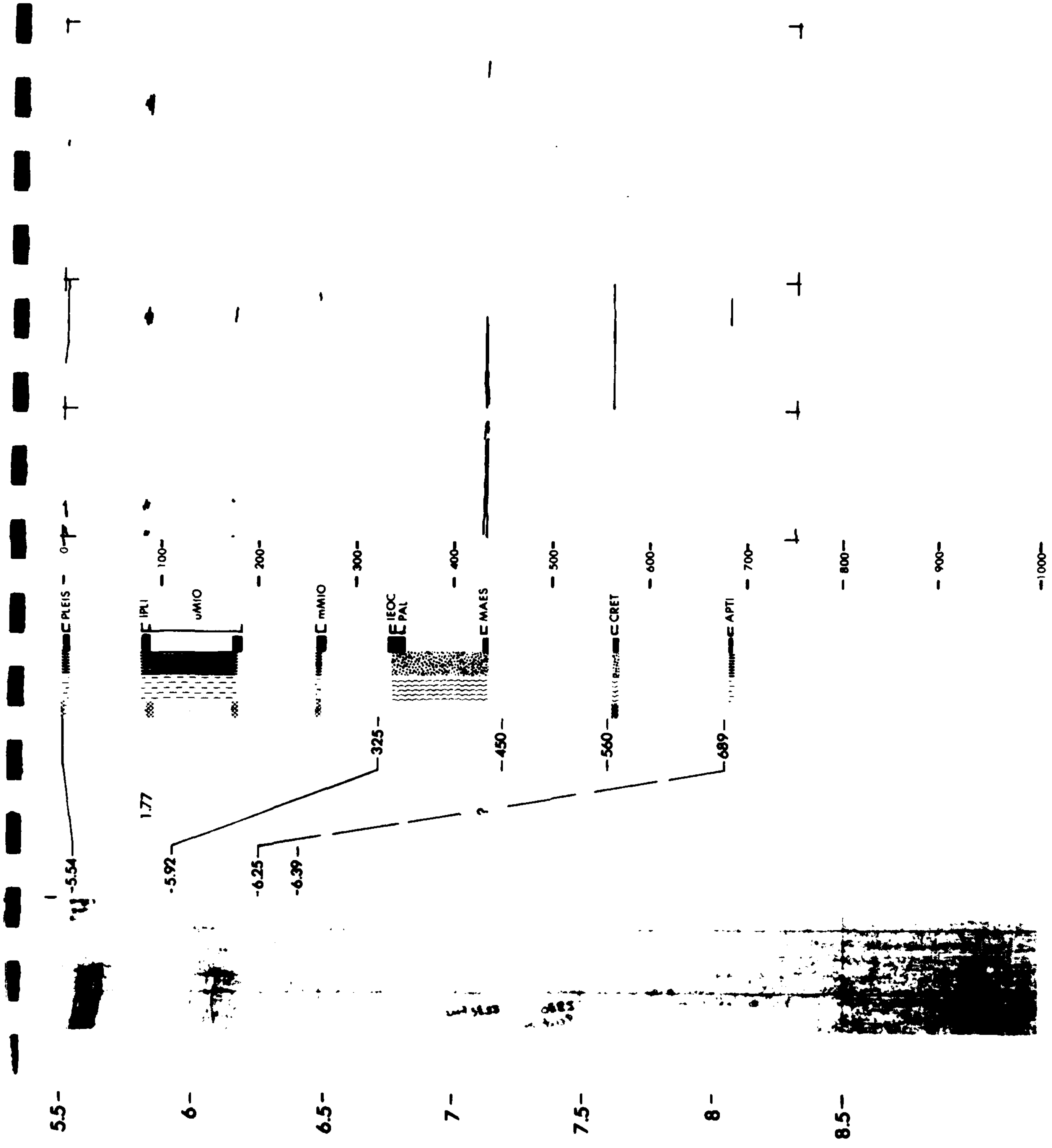
Calcareous ooze; nannofossil rich. In Cretaceous time thin beds; calcareous, hard or soft, also nannofossil rich.



135



SITE 135 LEG 14



SITE DATA

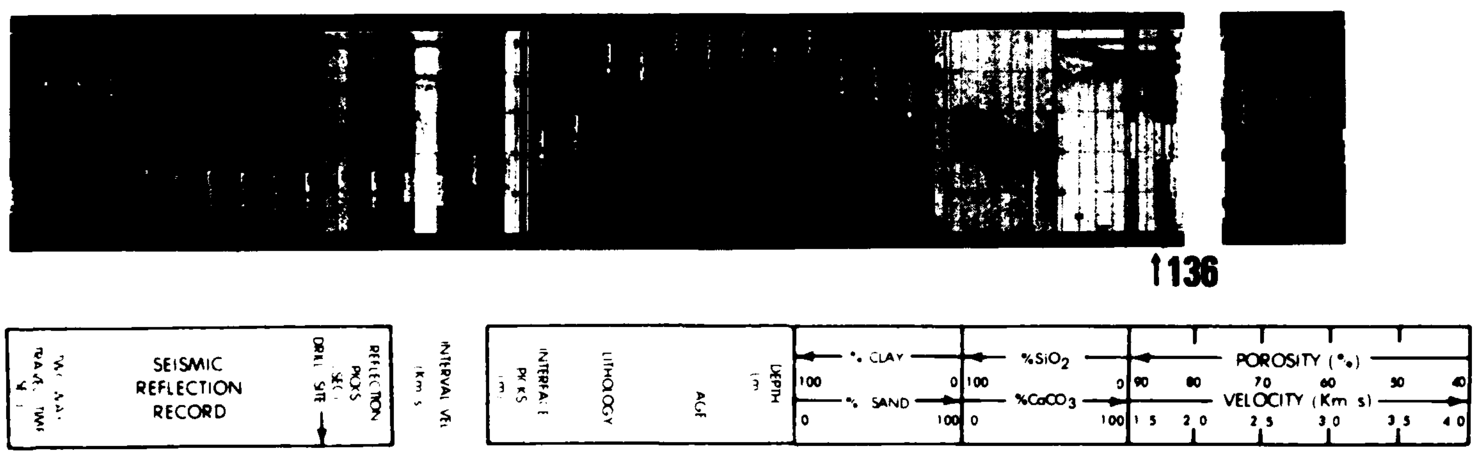
Position:
Latitude 34°10.1' N
Longitude 16°18.2' W
Date: 10/15/70
Time: 0600Z
Water depth: 4169 meters
Location: Southwest of Gibraltar,
Abyssal hills

CORE DATA

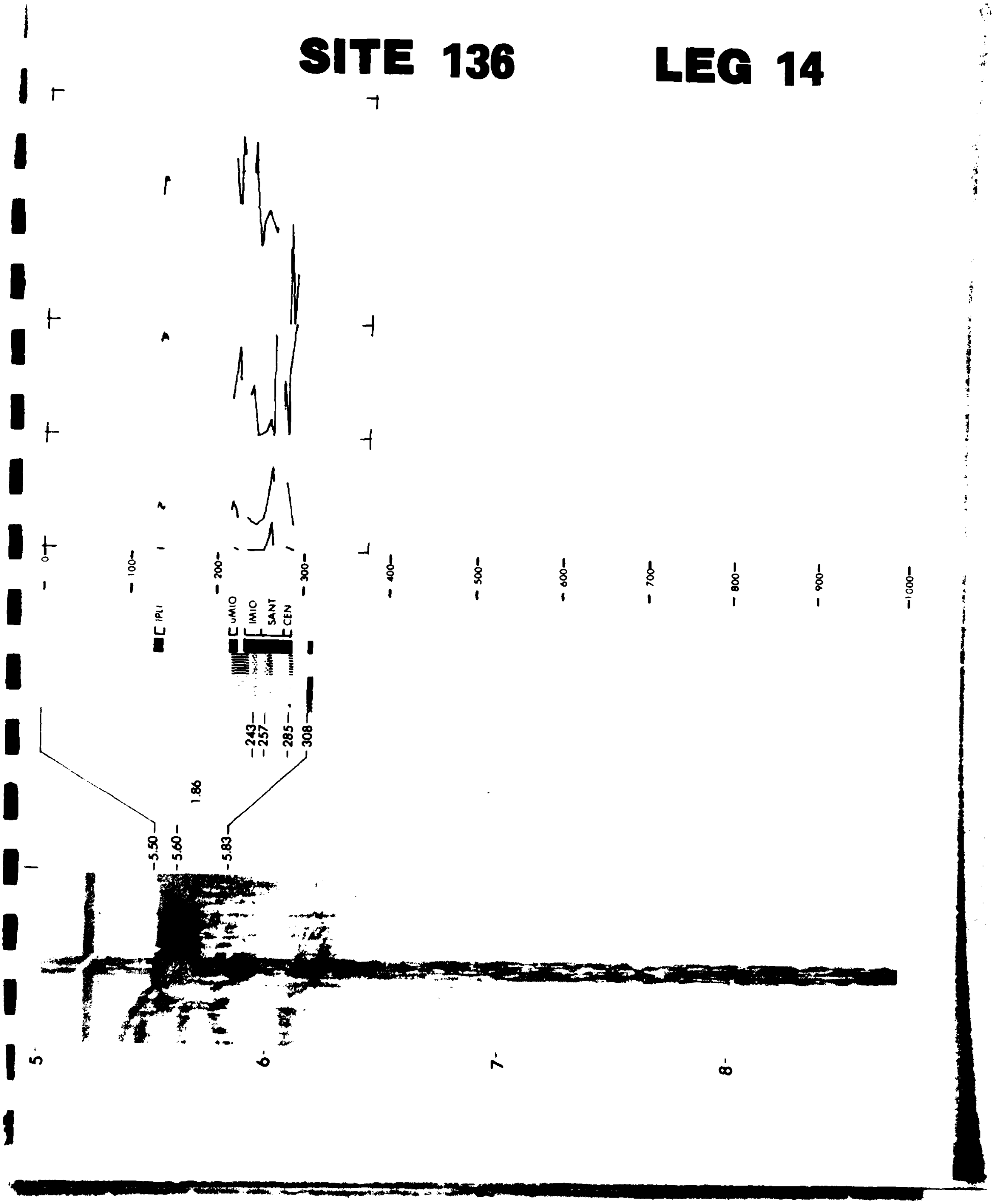
Penetration:
Drilled-- 236 meters
Cored---- 77 meters
Total---- 313 meters
Recovery:
Basement- 1 cores
.2 meters
Total---- 9 cores
34 meters

Pliocene to Miocene nannoplankton chalk ooze overlies early Miocene Clay. From 259 to 268 meters, the Miocene clay passes into a 9 meter interval of barren clay and then into Coniacian to Santonian ash and calcareous red clay. The time period represented by this 9-meter interval is about 60 million years. The oldest sediments cored were multicolored clays and, at 290 meters, nannoplankton marls of Late Aptian age Early Aptian shales were recovered, however, from bit cuttings. Oceanic basalt (tholeiitic diabase) was recovered at a depth of 308 meters which correlates well with the anticipated depth of the acoustic basement. The widespread occurrence of this basement reflector, its acoustic character, and the petrology of the basalt suggest that true oceanic basement was sampled. The oldest sediments at this site are therefore anomalously young considering the site's proximity to the continental margin and the crustal age inferred by Pitman and Talwani (1972) from the analysis of magnetic anomalies.

Interbedded calcareous and detrital sediments.



SITE 136 LEG 14



SITE DATA

Position:
Latitude 25°55.5' N
Longitude 27°03.6' W
Date: 10/24/70
Time: 0970Z
Water depth: 5361 meters
Location: Eastern Atlantic Basin

CORE DATA

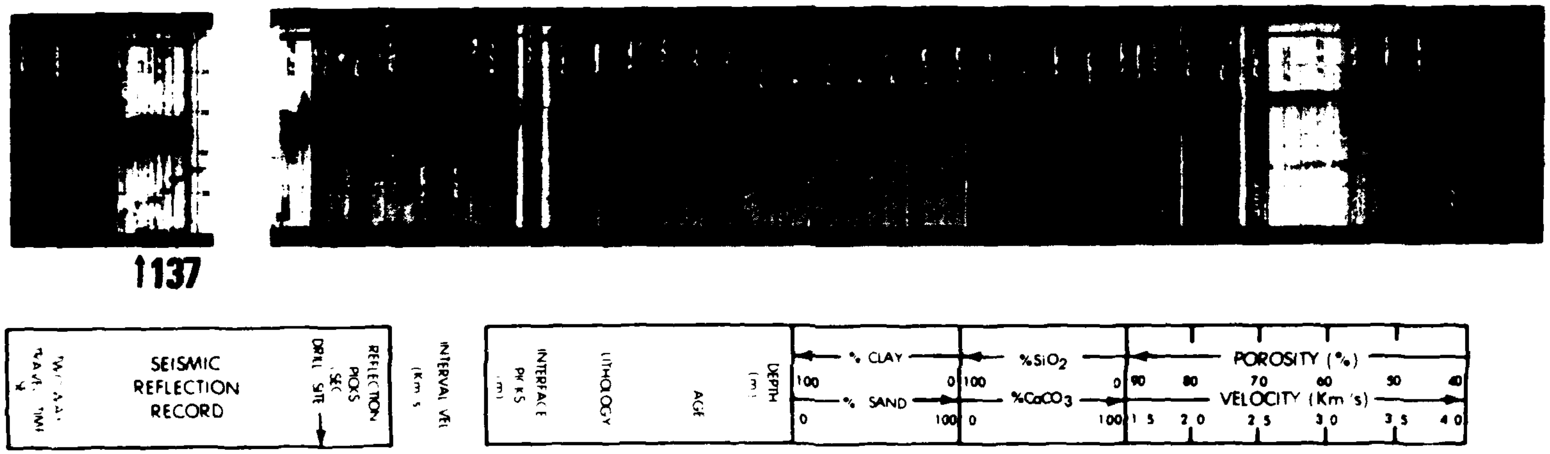
Penetration:
Drilled-- 265 meters
Cored---- 136 meters
Total---- 401 meters
Recovery:
Basement- 1 cores
1.4 meters
Total---- 17 cores
68 meters

Approximately 245 meters of brown clay, barren in the upper part, but early Tertiary to Campanian lower down, passes down through a 32-meter transitional zone of Turonian to Cenomanian black clay, calcareous clay and chert into about 120 meters of nannoplankton marl/chalk ooze of early Turonian to Cenomanian age.

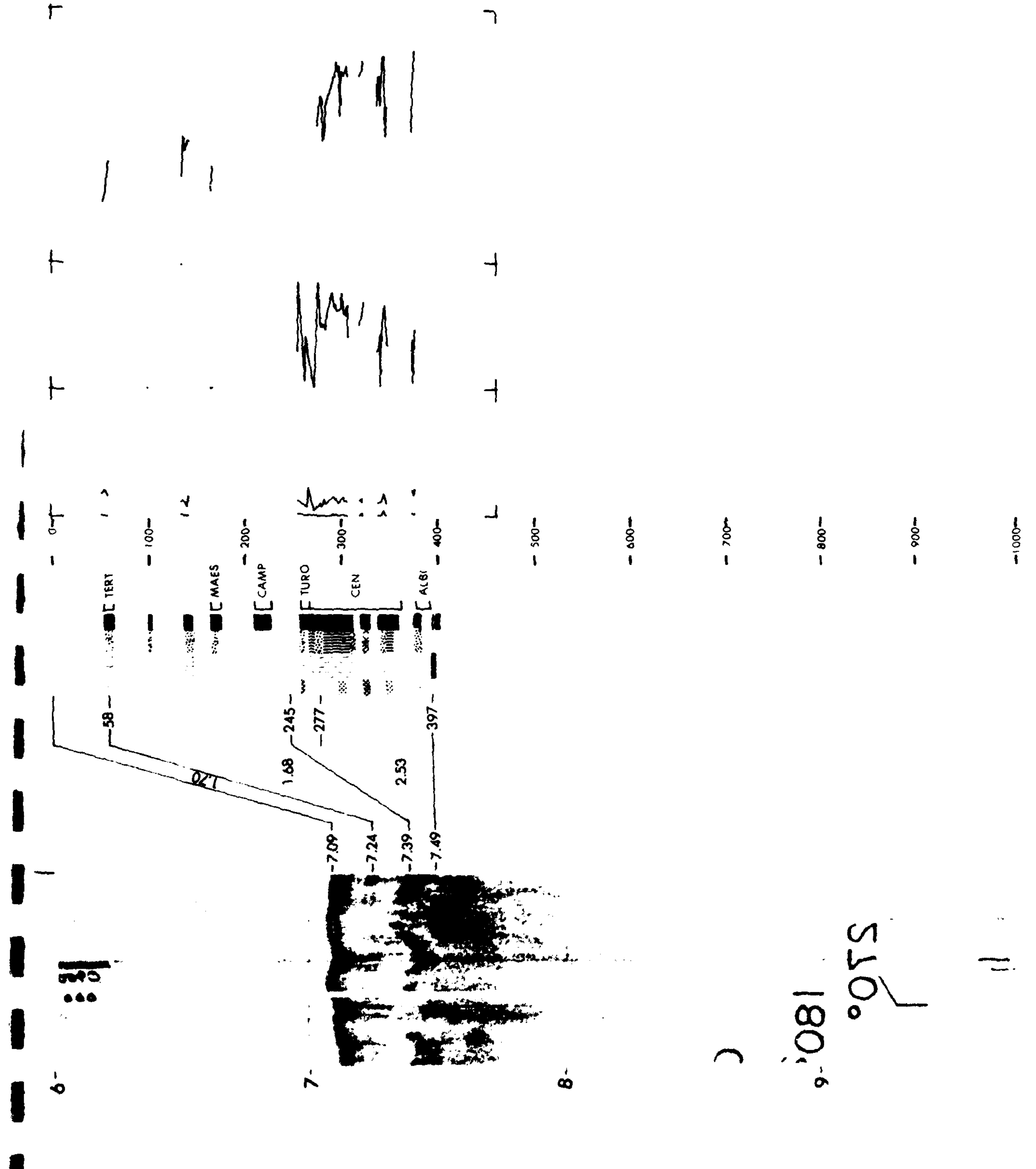
Basalt (believed to be layer 2) was reached at 397 meters subbottom and is correlated with the basement reflector at 0.40 second. Late Albian marl ooze was recovered in a sidewall sample three meters above the top of the basalt. The basalt is a strongly altered porphyritic flow rock cut by numerous veins; it has alkalic affinities.

Neither the drilling record nor the recovered core materials give an indication as to the true depth and nature of the thin intermediate reflector seen on the seismic records at about 0.15 second.

Cretaceous sediments calcareous with thin beds of detrital sediments. Calcareous sediment occasionally nannofossil rich.



SITE 137 LEG 14



SITE DATA

Position:
Latitude 25°55.4' N
Longitude 25°33.8' W
Date: 10/24/70
Time: 1800Z
Water depth: 5288 meters
Location: Continental Rise, West Africa

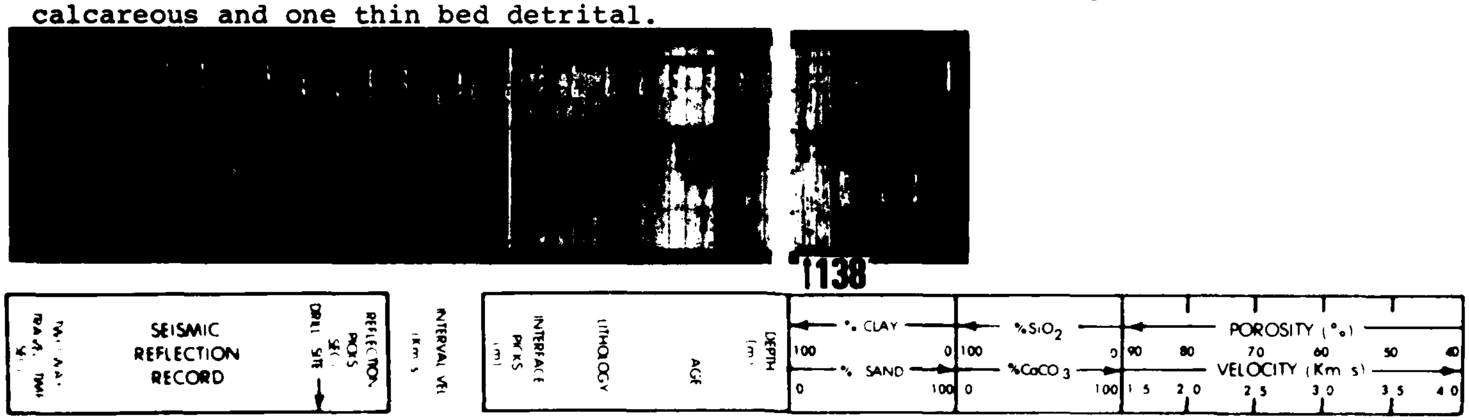
CORE DATA

Penetration:		
Drilled--	388	meters
Cored----	54	meters
Total----	442	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	7	cores
	23	meters

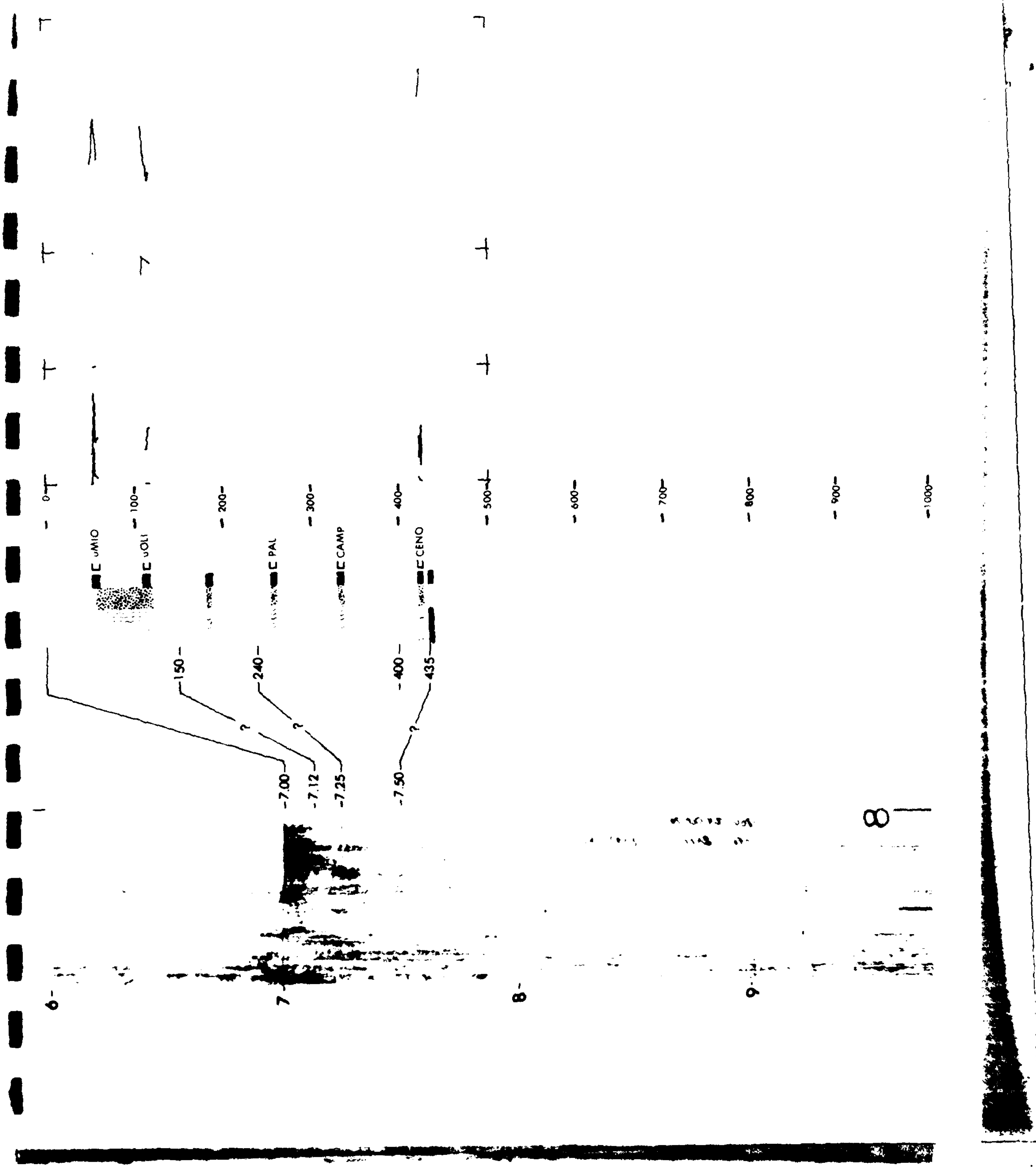
About 200 to 250 meters of Tertiary clay, silt, and sand rest on 190 to 240 meters of Upper Cretaceous sediment. The Cretaceous lithology is mainly mudstone and shale with thin chert layers at 255 meters, clay at 332 meters, and dolomite silt and dolomite clay cyclically interbedded with carbonaceous mud at 425 meters. A 50-cm thick layer of fine grained altered basalt lies within one dolomite-clay sequence. At a subbottom depth of 437 meters the hole bottomed in coarse grained slightly altered basalt with alkalic affinities. If this unit represents the basement reflector at about 0.50 second on the CHALLENGER seismic profile, then average compressional wave velocities (~1.75 km/sec) for the complete sedimentary succession are lower than expected. Also, the age of sediment above the basalt appears younger than at Site 137 (nearer the ridge crest), suggesting the basalt at Site 138 is an intrusive sill and not the top of oceanic layer 2. One of the intermediate reflectors on the CHALLENGER profile may be caused by the indurated shale and chert in Core 4 (~255 meters).

Calcareous fossils are very rare or absent throughout the entire succession at Site 138. Radiolaria are moderately common throughout, and diatoms and microplankton occur in places.

Tertiary; one thin bed of detrital sediment. Cenomanian age; one thin bed calcareous and one thin bed detrital.



SITE 138 LEG 14



SITE DATA

Position:
Latitude 23°31.1' N
Longitude 18°42.3' W
Date: 10/29/70
Time: 0010Z
Water depth: 3047 meters
Location: Continental Rise, West Africa

CORE DATA

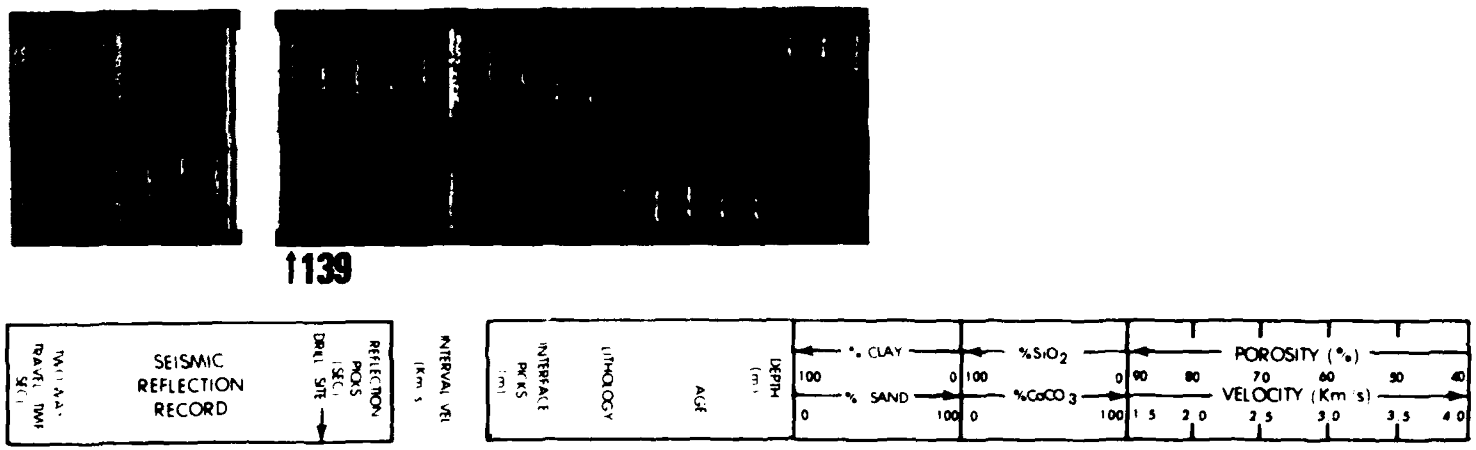
Penetration:
Drilled-- 604 meters
Cored---- 61 meters
Total---- 665 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 7 cores
17 meters

About 520 meters of nannoplankton chalk and marl ooze, with small terigenous component increasing downwards, overlies at least 140 meters of diatom ooze with interbedded quartz sands. The carbonate sequence is Early to Middle Miocene and younger in age, and the siliceous material Early Miocene.

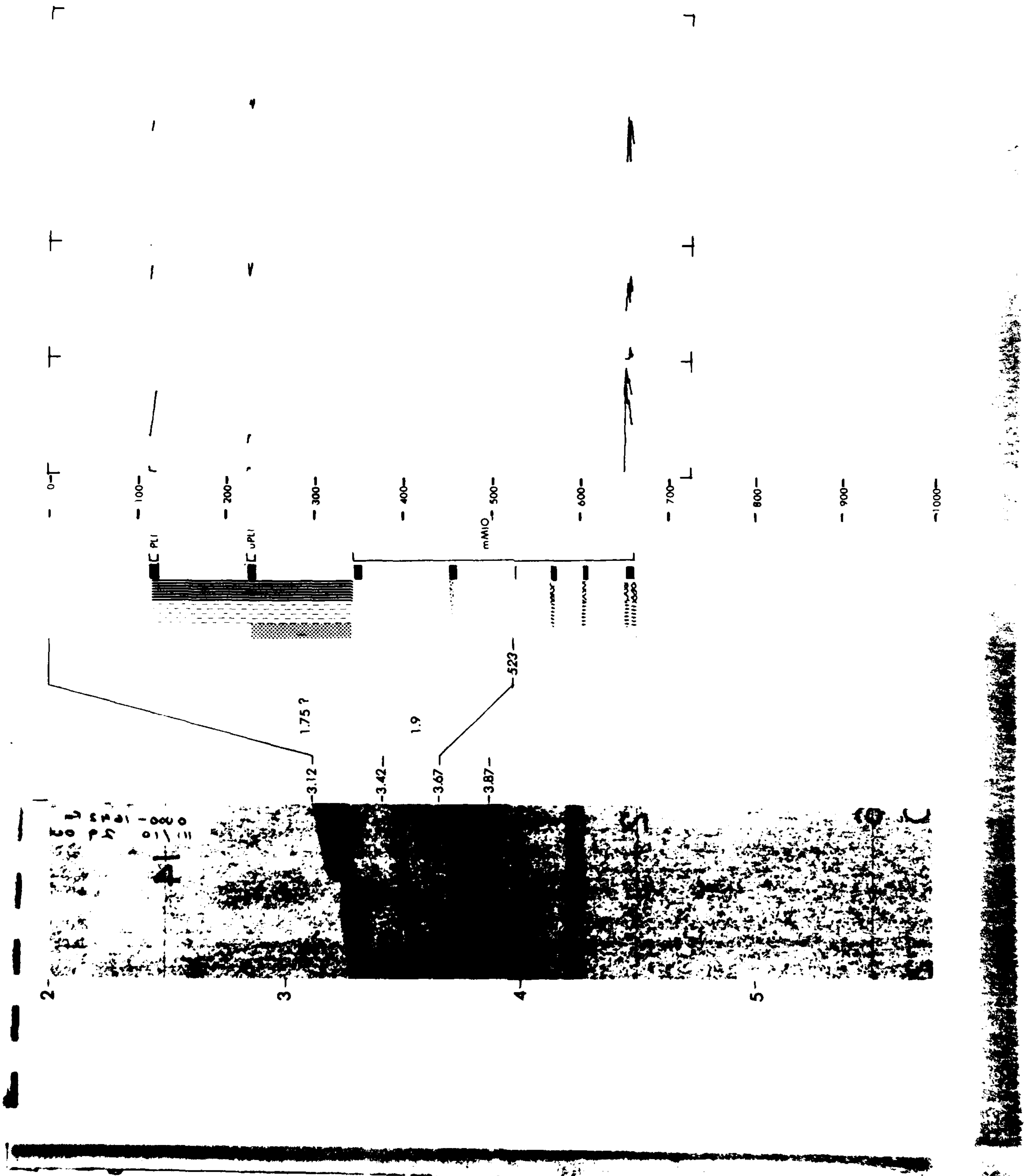
The strongest intermediate reflector seen on the seismic profiles is at about 0.60 second, which may correspond with the pronounced change in lithology at a depth of 523 meters.

The sediments show a marked salinity gradient from 33 ppt in Core 1 to 75 ppt in Core 7.

Calcareous sediment; nannofossil rich. Middle Miocene; one thin bed, siliceous, diatom rich.



SITE 139 LEG 14



SITE DATA

Position:
Latitude 21°45.0'N
Longitude 21°47.5'W
Date: 10/31/70
Time: 1450Z
Water depth: 4483 meters
Location: Continental Rise, West Africa

CORE DATA

Penetration:	140	140A	
Drilled--	598	235	meters
Cored----	53	18	meters
Total----	651	253	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	8	2	cores
	30	9.1	meters

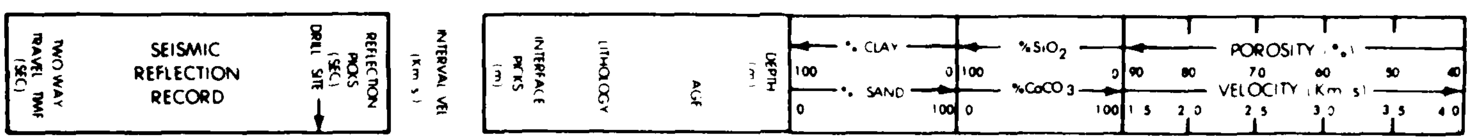
About 150 meters of nannoplankton chalk ooze of Pliocene age and younger, and 75 meters of silty clay and diatom ooze of Miocene age overlie, with a pronounced hiatus of 20 to 25 million years, at least 400 meters of Middle Eocene to Upper Cretaceous siliceous clay, shale, and chert with thin silt and sand beds. Dolomite is common to abundant in some silt beds.

The Miocene and older sediments contain an abundance of detrital quartz. Nearly all sediments from this site show evidence of redeposition and have high sedimentation rates.

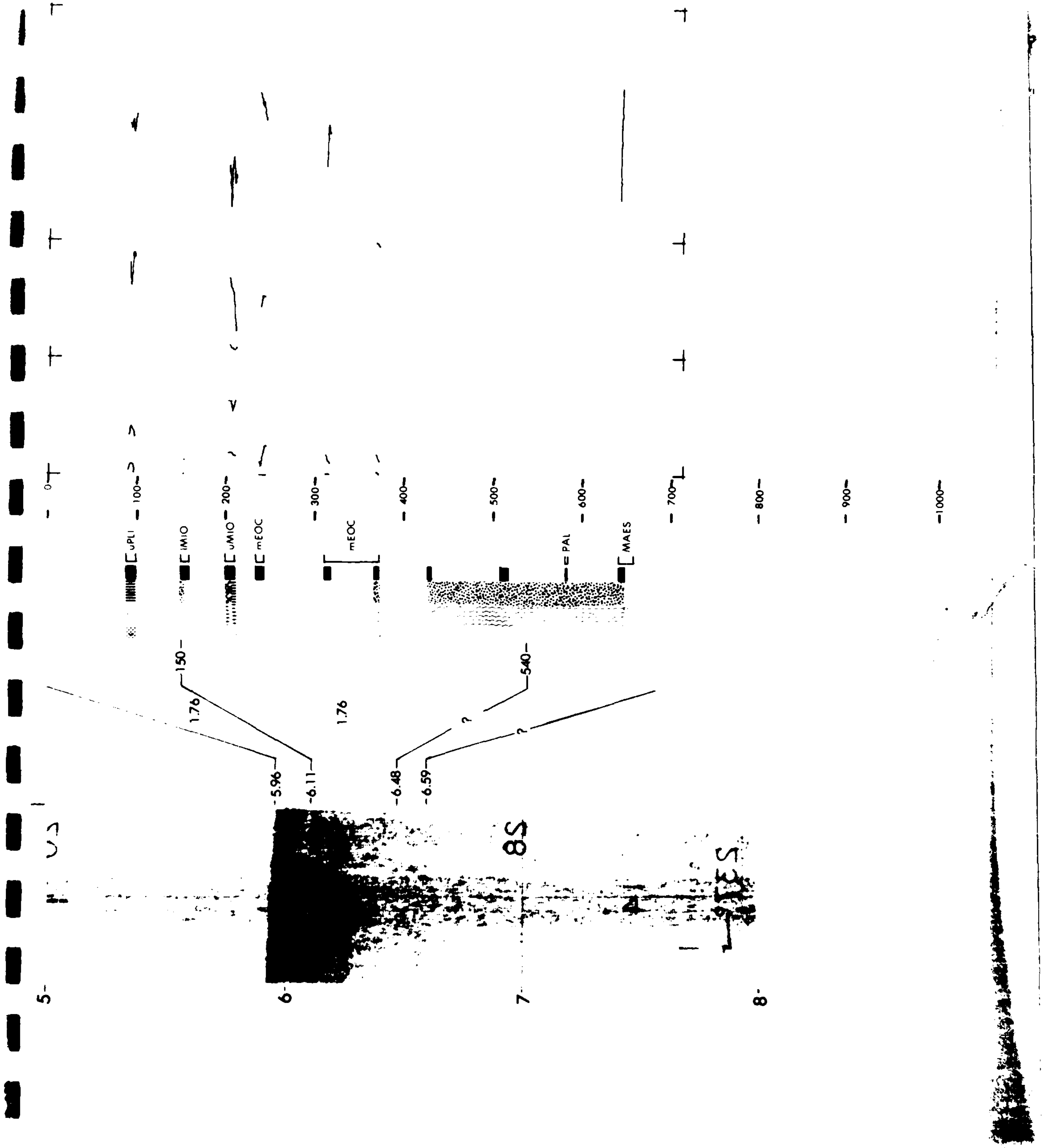
The first major zone of reflectors on the CHALLENGER seismic record can be correlated with the major lithologic changes from calcareous ooze above to silty clay below

Upper Pliocene, calcareous sediment, nannofossil rich. Lower Miocene, siliceous sediment diatom rich.

140



SITE 140 LEG 14



SITE DATA

Position:
- Latitude 19°25.2' N
- Longitude 23°59.9' W

Date: 11/05/70
Time: 0800Z
Water depth: 4148 meters
Location: North of Cape Verde Islands

CORE DATA

Penetration:
- Drilled-- 217 meters
- Cored---- 81 meters
- Total---- 298 meters

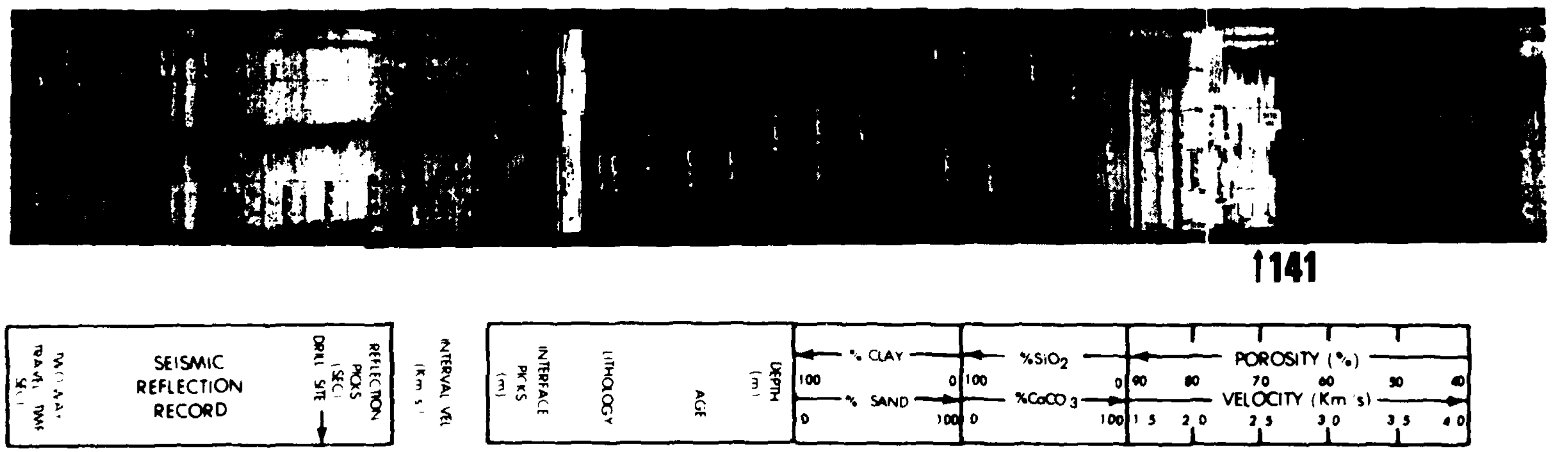
Recovery:
- Basement- 1 cores, 1 meters
- Total---- 10 cores, 72 meters

About 80 meters of chalk ooze of Pleistocene to Pliocene age rests on about 200 meters of brown, red, and green barren clays. These sediments rest on a highly altered, serpentinized basalt at a subbottom depth of 295 meters.

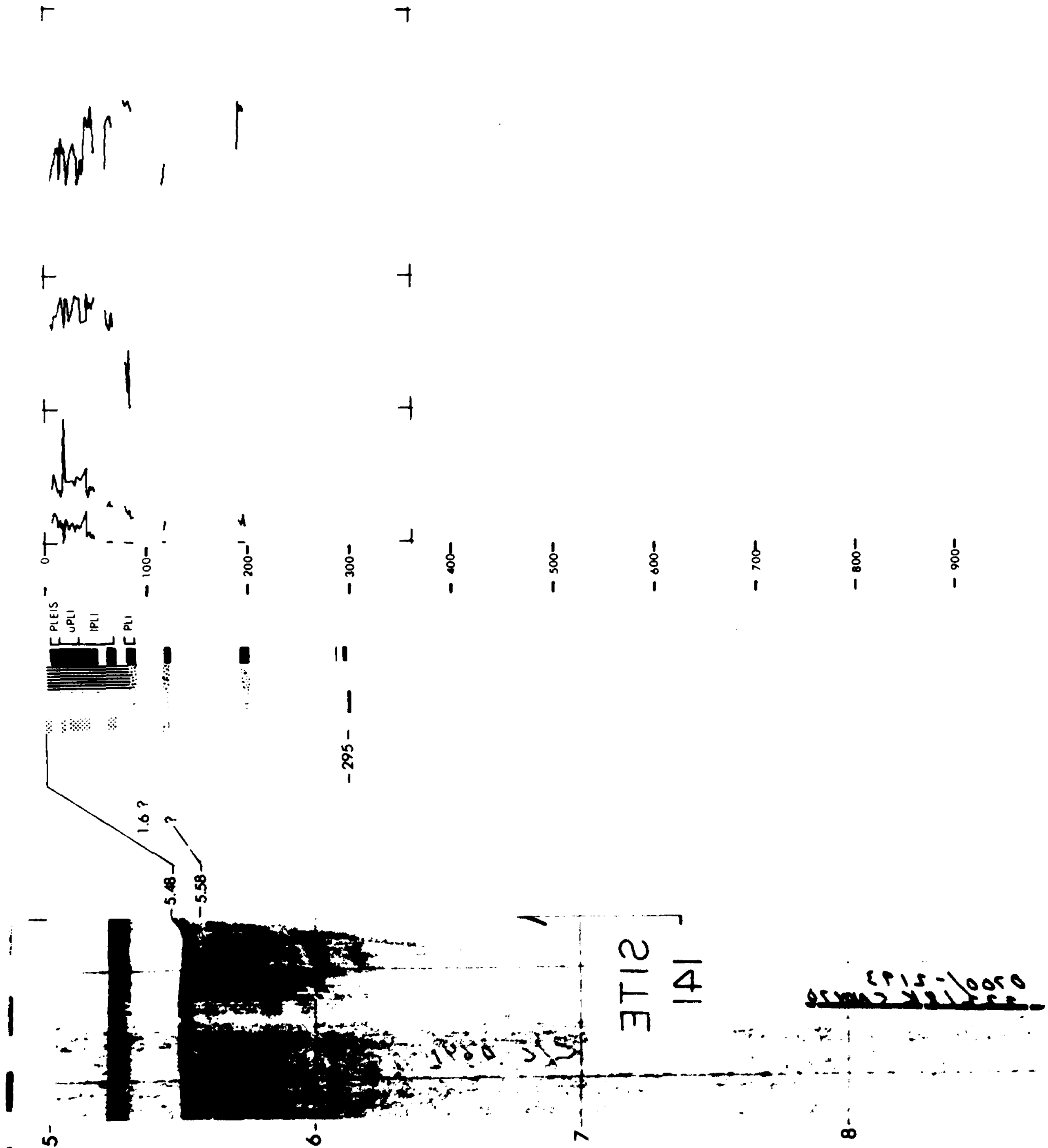
The transition from non-carbonate to carbonate sediments occurs at a total depth of 4232 meters below sea level, which is about 400 meters shallower than that of other sites in the area, and indicates a significant uplift since early Pliocene at this site of deposition.

The structure which was drilled has an appearance on seismic reflection records similar to that of known salt diapirs. The diapiric structure is represented by a steep-sided zone of no acoustic reflection. Neither the ooze-clay boundary nor the underlying basalt are represented by identifiable reflecting horizons. Hole 141 was drilled in the crest of a structure that has a topographic expression of about 40 meters and a diameter of 2 to 4 km. Several apparently similar structures are present nearby.

Calcareous sediment nannofossil or foraminifera rich. Pliocene; calcareous with two thin beds, detrital and silica rich.



SITE 141 LEG 14



SITE DATA

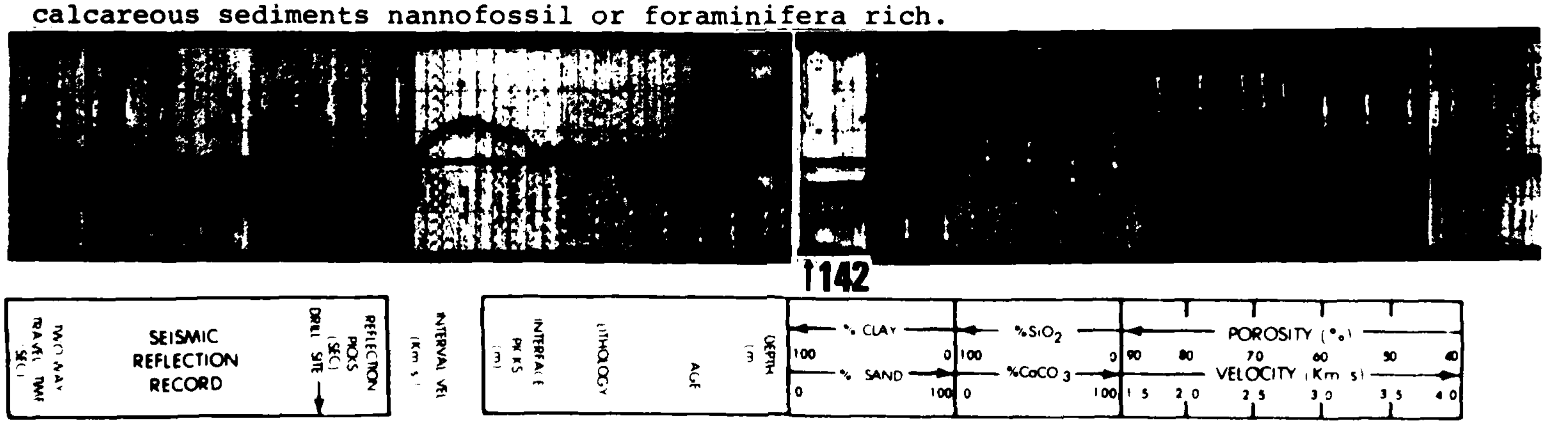
Position:
Latitude $3^{\circ}22.1'$ N
Longitude $42^{\circ}23.5'$ W
Date: 11/13/70.
Time: 1147Z
Water depth: 4372 meters
Location: Ceara Abyssal Plain

CORE DATA

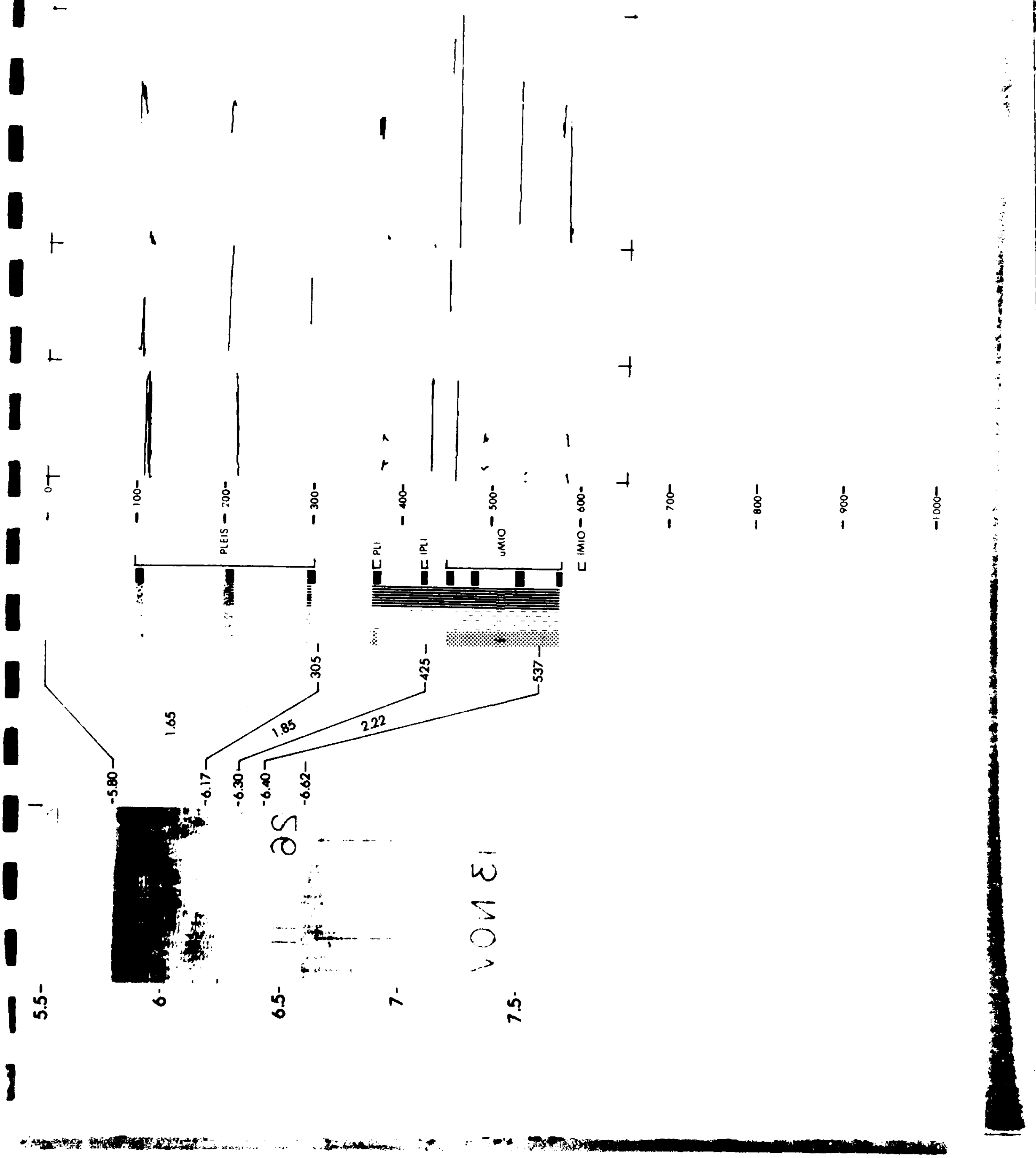
Penetration:
Drilled-- 537 meters
Cored---- 72 meters
Total---- 609 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 9 cores
41 meters

The seismic reflection profile at Site 142 shows three main units in the abyssal plain sediments abutting against the flank of the Ceara Rise. An upper reflective zone represents a unit about 305 meters thick and consists of Pleistocene subarkosic silty sand and calcareous mud to nannoplankton marl ooze. A transparent zone represents a unit about 120 meters thick and consists of Pliocene foraminifera nannoplankton chalk ooze passing down into calcareous clay, foram sand, and sandy silt. A lower reflective zone represents a unit about 100 meters thick and consists of interbedded marl muds, nannoplankton marl/chalk ooze, foram sands, and clay. The age of this unit ranges from topmost Miocene to the Early Miocene. The top of this zone is defined by a very prominent seismic reflector which extends over thousands of square kilometers. The reflecting horizon boundary coincides with transition from Unit 2 to Unit 3, described above, and may serve as an important Pliocene/Miocene marker horizon. The flank of the Ceara Rise was penetrated near 537 meters sub-bottom. Only one core, indurated nannoplankton marl mud of Early Miocene age, was recovered beneath this level. At about 606 meters sub-bottom, a center bit sample of nannoplankton mark yielded an Early Miocene flora.

Pleistocene sediments interbedded calcareous, and detrital. Upper Miocene calcareous sediments nannofossil or foraminifera rich.



SITE 142 LEG 14



SITE DATA

Position:
- Latitude $9^{\circ}28.4'$N
- Longitude $54^{\circ}18.7'$W

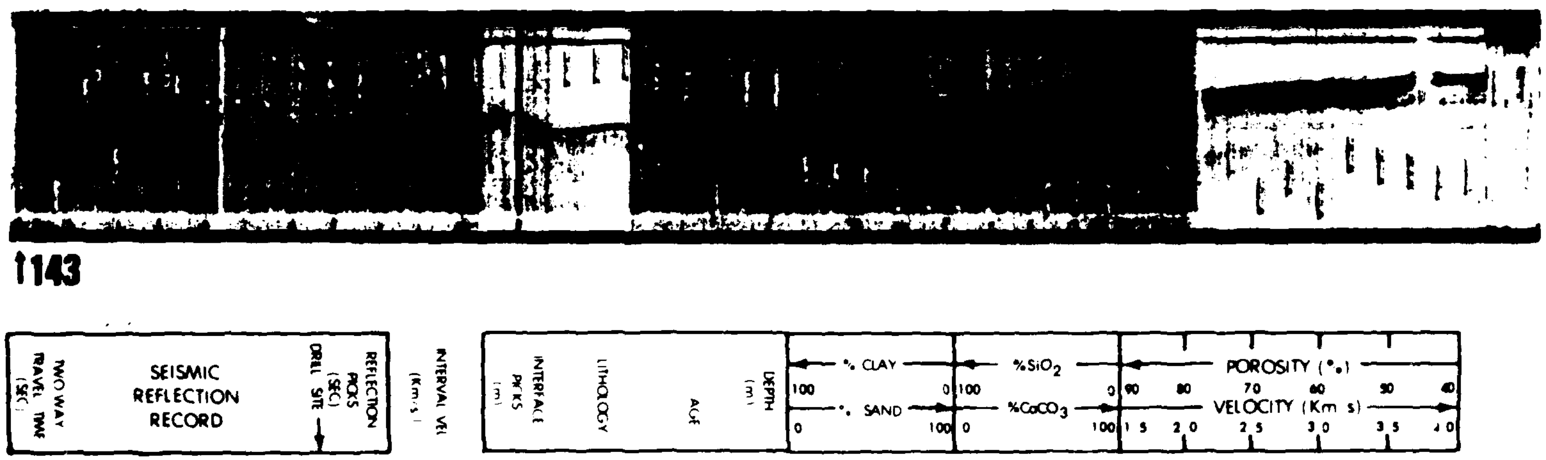
Date: 11/19/70
Time: 1300Z
Water depth: 3493 meters
Location: Demerare Rise; Guiana coast

CORE DATA

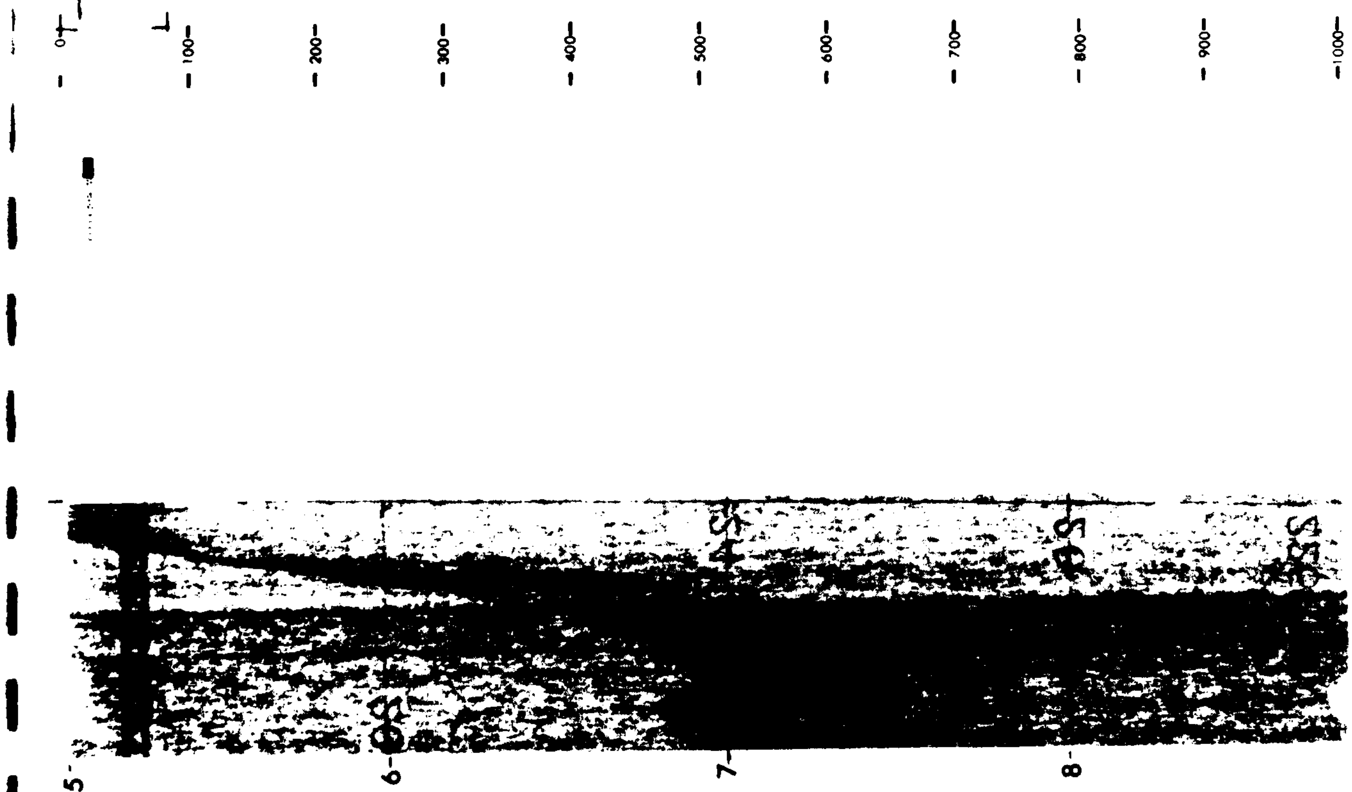
Penetration:	143	143A	143B	143C	143D	
Drilled--	32	14	36	40	18	meters
Cored----	0	9	0	9	0	meters
Total----	32	23	36	49	18	meters
Recovery:						
Basement-	0	0	0	0	0	cores
	0	0	0	0	0	meters
Total----	0	1	0	0	0	cores
	0	3	0	0	0	meters

Site 143 lies about halfway down the lower part of the Demerara Rise and Site 144 lies near the top just below the edge of the flat upper plateau, about 3 km southwest of Site 143 and 400 km north of the Guiana coast.

Only one core of Cretaceous material was recovered at Site 143 (at sea floor) before technical problems necessitated abandoning the site. It is highly contaminated with Recent material, but also contains some Creteceous foraminifera and nannoplankton. These indicate an age of Late Albian to Cenomanian. The fossil assemblage is very similar to that of Core 5 in Site 144. The sediment recovered was conglomeratic sand and gravel. The disaggregated nature of the core material and its very heterogeneous nature strongly suggest a talus deposit.



SITE 143 LEG 14



SITE DATA

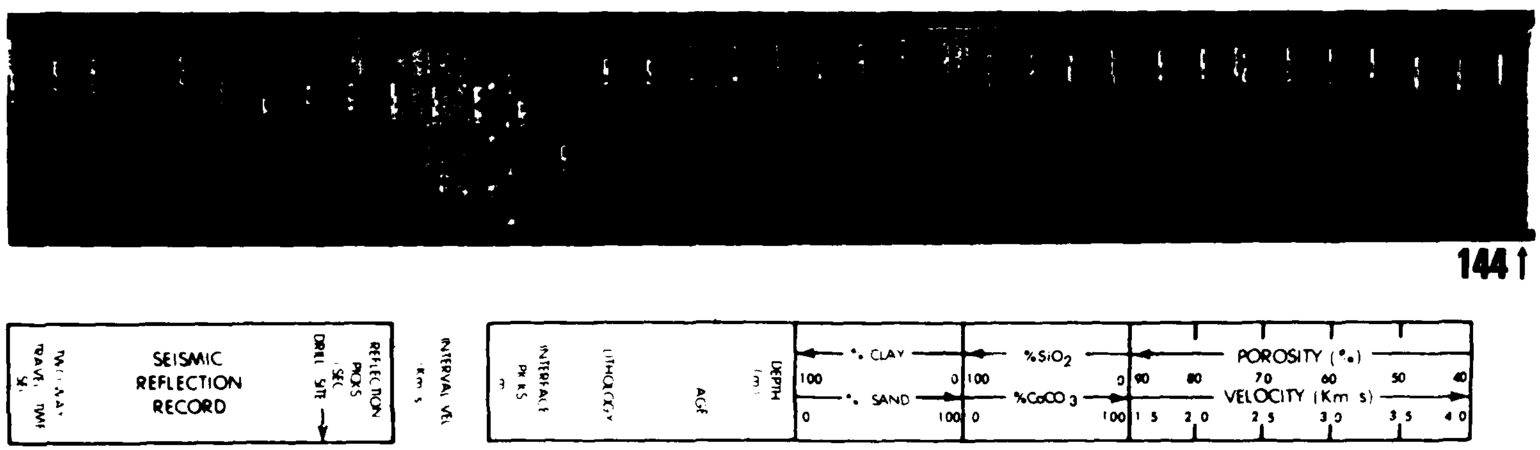
Position:
Latitude 9°27.2' N
Longitude 54°20.5' W
Date: 11/27/70
Time: 1210Z
Water Depth: 2957 meters
Location: Demerare Rise; Guiana coast

CORE DATA

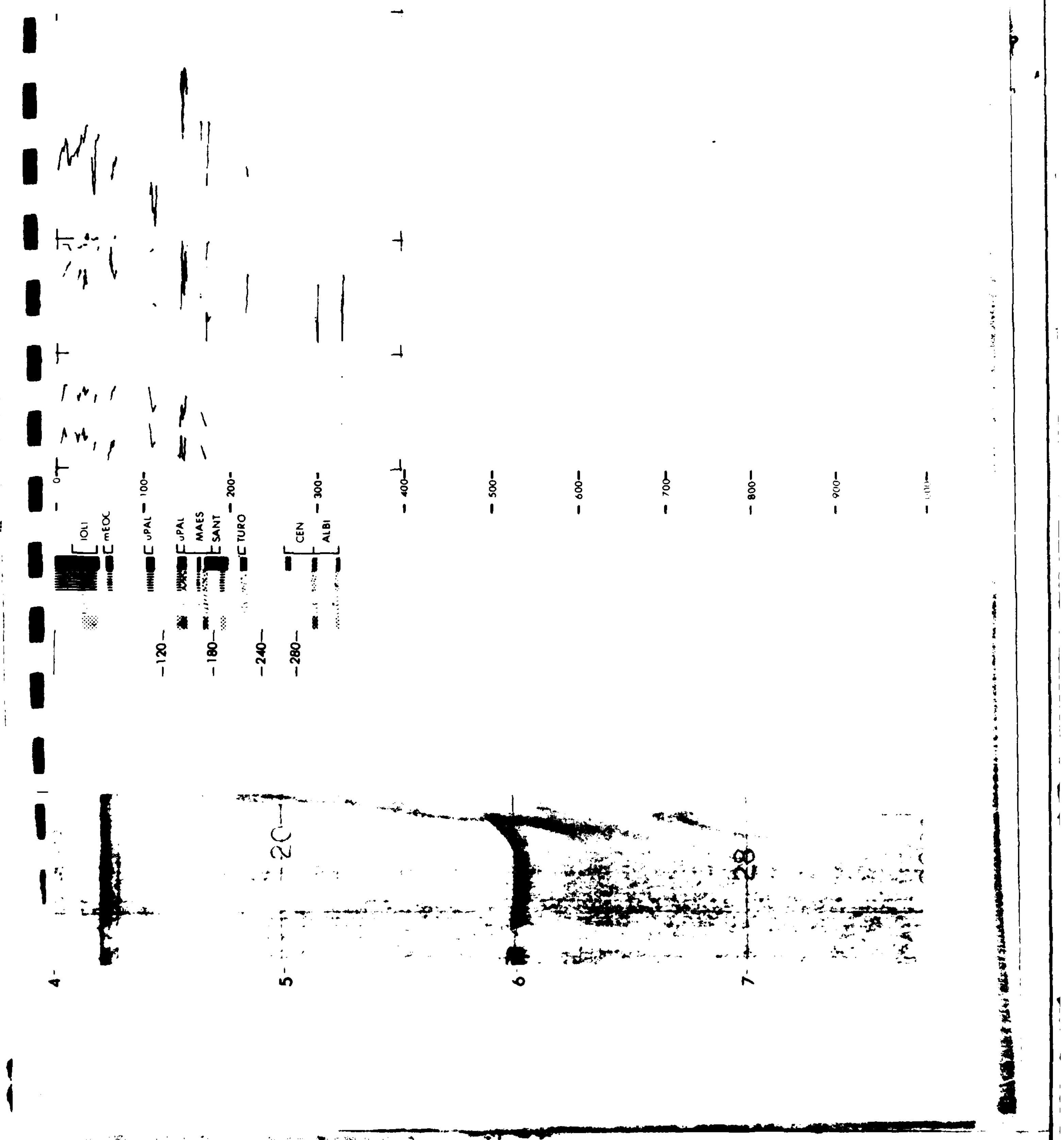
Penetration:	144	144A	144B	
Drilled--	288	146	9	meters
Cored----	39	54	27	meters
Total----	327	200	36	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	8	6	3	cores
	28	29	27	meters

The succession at Site 144 consists of Oligocene to Paleocene foraminifera-nannoplankton chalk ooze with Radiolaria in the Eocene. Three small hiatuses were detected; one in the Late Eocene at 46 meters; one at the Tertiary Cretaceous boundary at 147 meters; and one between Late Campanian and Early Santonian at 180 meters. Paleocene and Maestrichtian sediments are mainly zeolitic marl. At 180 meters there is a pronounced lithology change to zeolitic calcareous carbonaceous shale, with a strong H_2S odor, which is mainly of Senonian to Turonian age. Marl, quartzose marlstone, shelly limestone, and carbonaceous clay were deposited from Cenomanian to Aptian times. Sediments formed at the site of deposition, and those from neighboring marginal shelves and the continent, indicate regional subsidence over a long period of time. The area of Site 144 was a poorly oxygenated environment in the Cretaceous with abundant quartz, carbonate, and organic matter introduced from upslope into this area of clay deposition. In the Tertiary, fertility increased and pelagic constituents began to dominate in a well-oxygenated environment at the sea floor.

Calcareous sediments occasionally either nannofossil or foraminifera rich.



SITE 144 LEG 14



SITE DATA

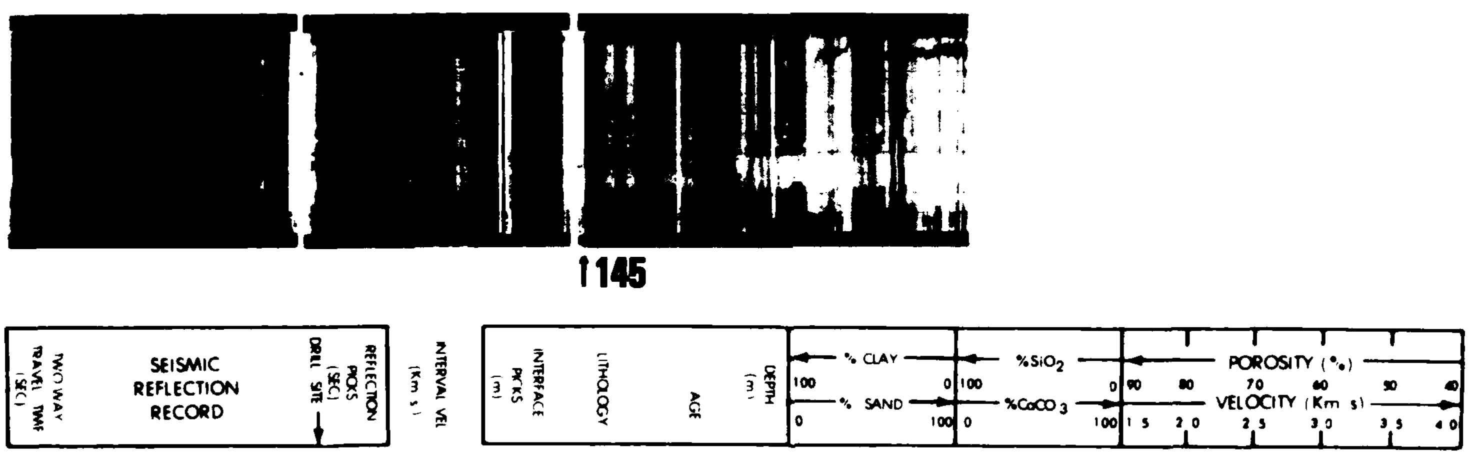
Position:
- Latitude 16°34.7' N
- Longitude 68°03.4' W

Date: 12/06/70
Time: 0145Z
Water depth: 4358 meters
Location: Venezuelan Basin

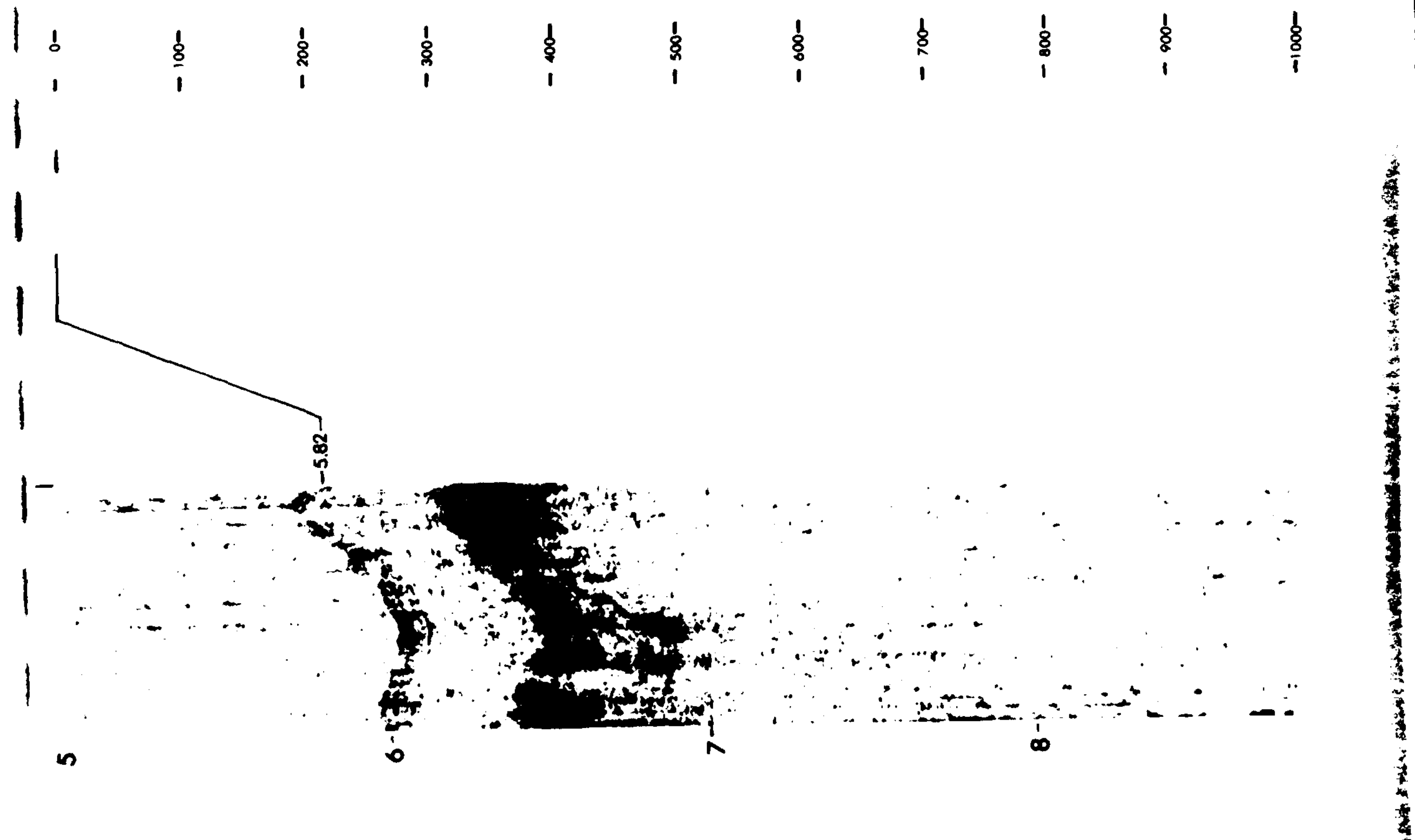
CORE DATA

Penetration:	
Drilled--	0 meters
Cored----	0 meters
Total----	0 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	0 cores
	0 meters

No information given on this site.



SITE 145 LEG 15



SITE DATA

Position:
Latitude 15°07.0' N
Longitude 69°22.7' W
Date: 12/15/70
Time: 0900Z
Water depth: 3949 meters
Location: Central Venezuelan Basin

CORE DATA

Penetration:	146	146A	
Drilled--	388	87	meters
Cored----	374	9	meters
Total----	762	96	meters
Recovery:			
Basement-	1	0	cores
	9.5	0	meters
Total----	44	1	cores
	145	4	meters

Sites 146 and 149 were drilled within 2 km of each other in the central Venezuelan Basin and are discussed as one site.

At Site 149 oozes and chalks of the Cenezoic were cored to 382 meters where hard limestones and cherts of Horizon A" were encountered (406 m at Site 146). The Early (?) Eocene to early Early Miocene sediments are characterized by abundant Radiolaria.

At Site 146 sediments below Horizon A" were cored to Horizon B", identified as dolerite sills intruded into Coniacian limestones. Cherts and limestones of the Early (?) Eocene overlie noncalcareous Paleocene claystone. The Campanian and Maestrichtian pelagic marl and chalk contrast with the varied lithology of the Santonian which consists of silicified radiolarian limestone, with intercalated basaltic ash, carbonaceous layers, and radiolarian sands.

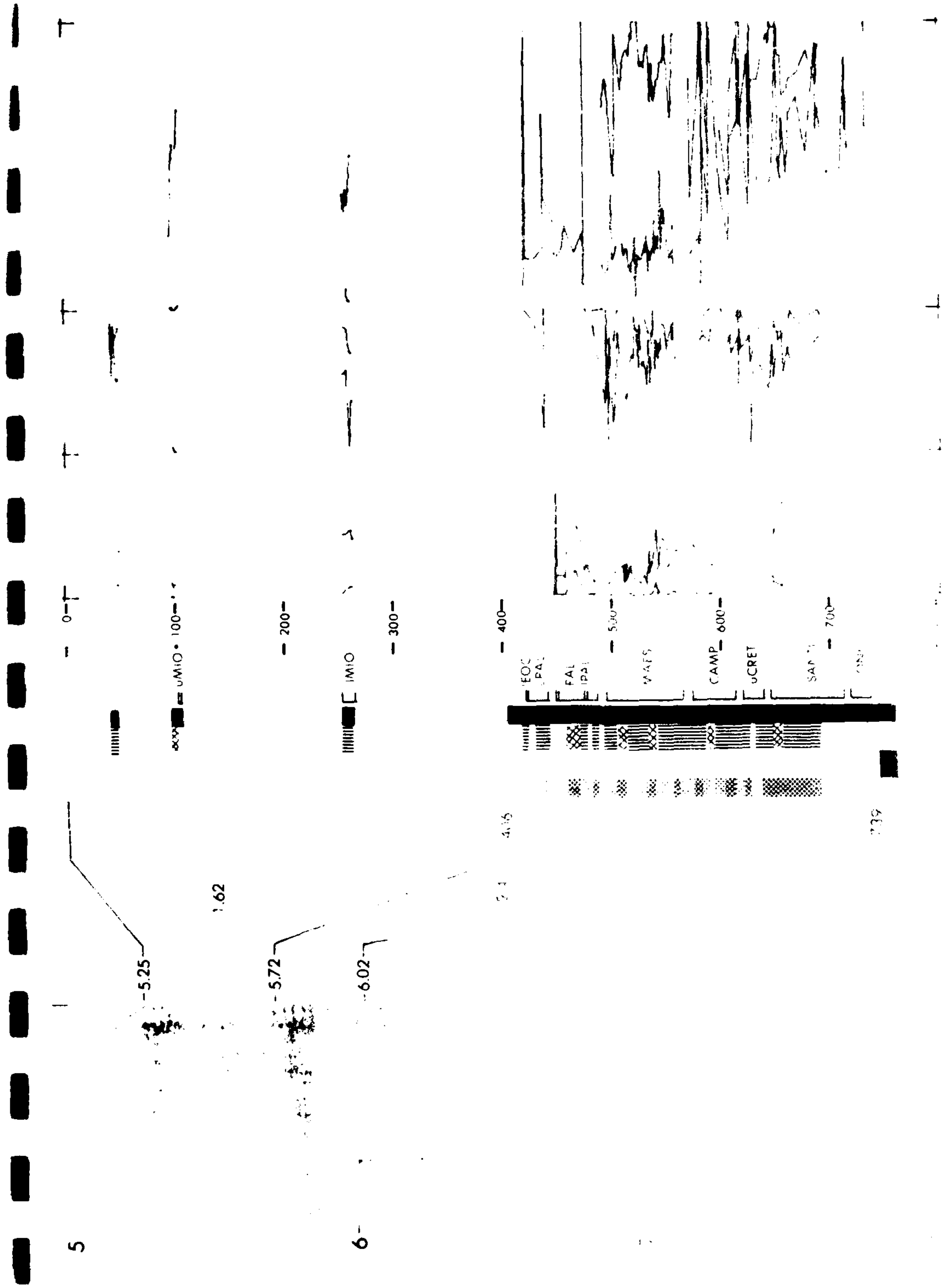
The upper contact of dolerite with the overlying sediment was not recovered, but the lower contact with an underlying limestone 0.5 meter thick showed a chill zone about 2 cm thick. The upper contact of the underlying sill was also not recovered.

Most calcareous sediments; nannofossil rich, rarely radiolaria ...

146

TWO-WAY TRAVEL TIME SEC	SEISMIC REFLECTION RECORD	REFLECTION PICKS SEC DRILL SITE	INTERVAL VEL Km/s	INTERFACE PICKS m	LITHOLOGY	AGE	DEPTH	% CLAY 100–0 / % SAND 0–100	% SiO2 100–0 / % CaCO3 0–100	POROSITY (%) 90 80 70 60 50 40 / VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 146 LEG 15



SITE DATA

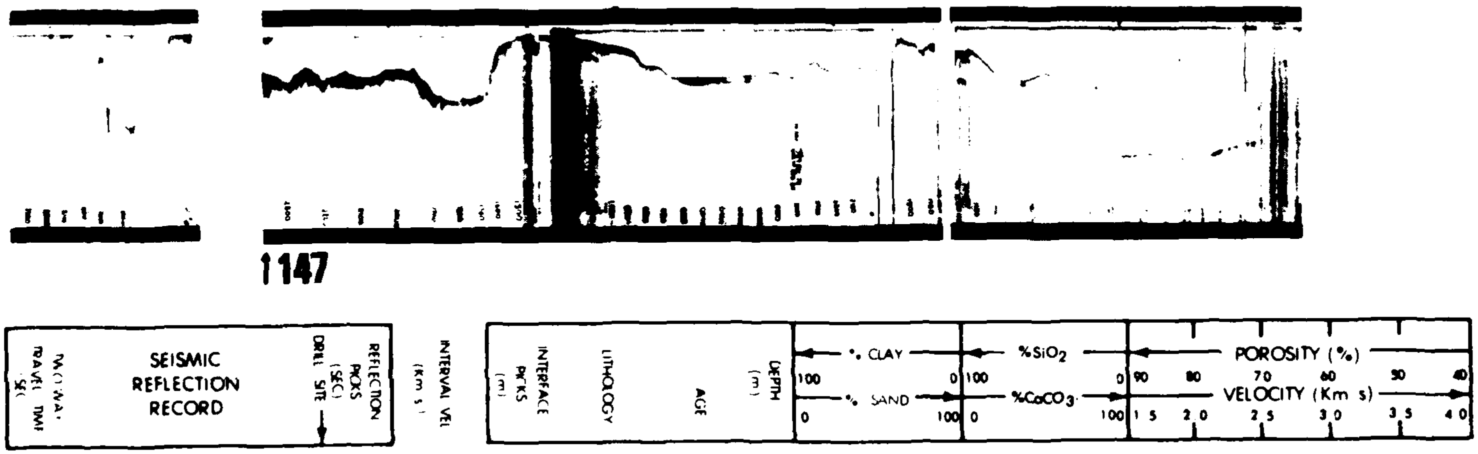
Position:
Latitude 10°42.5' N
Longitude 65°10.5' W
Date: 12/29/70
Time: 2300Z
Water depth: 892 meters
Location: Cariaco Basin

CORE DATA

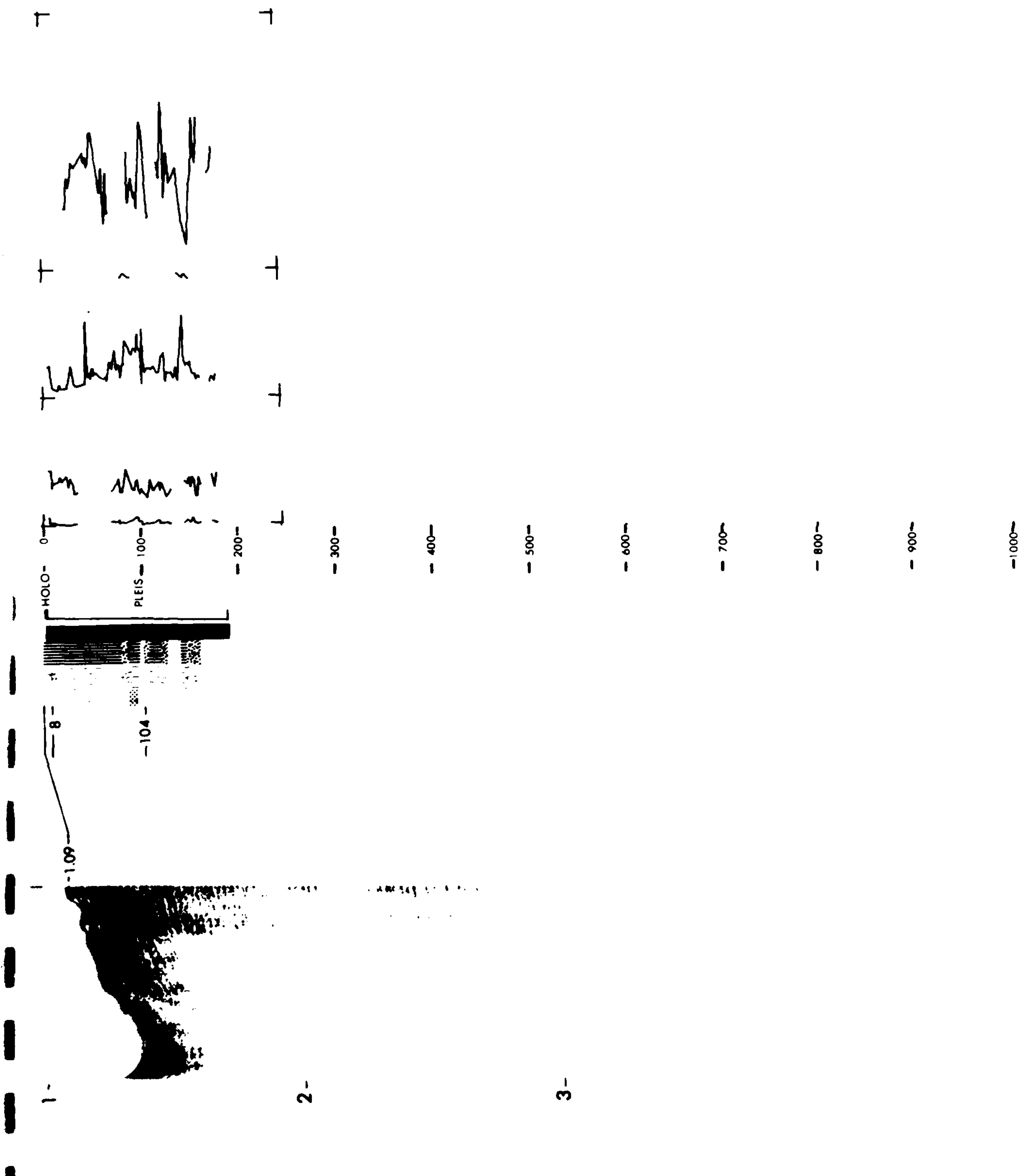
Penetration:	147	147A	147B	147C	
Drilled--	0	0	10	116	meters
Cored----	162	13	115	73	meters
Total----	162	13	125	189	meters
Recovery:					
Basement-	0	0	0	0	cores
	0	0	0	0	meters
Total----	18	2	12	8	cores
	119	6	80	32	meters

The site is located on a ridge separating two small deeps in the Cariaco Basin (Trench), a fault depression in the Venezuelan continental shelf that is characterized by the presence of anaerobic water below 360 meters. The sediment is a uniform organic-rich olive gray clay interrupted at three levels by gray and brown clays low in organic content. The average organic content is about 1.5 percent or about twice that of the average marine sediment. The upper few meters of the site (Holocene) contain about 4 percent organic carbon. From piston core data the gray and brown clays were related to the low stand of sea level associated with glaciation (Wisconsin). A relationship of similar clays deeper in the hole with earlier glacial events is not evident.

Calcareous sediments occasionally nannofossil rich.



SITE 147 LEG 15



SITE DATA

Position:
Latitude $13^\circ 25.1'$ N
Longitude $63^\circ 43.2'$ W
Date: 01/04/71
Time: 1300Z
Water depth: 1232 meters
Location: Aves Ridge

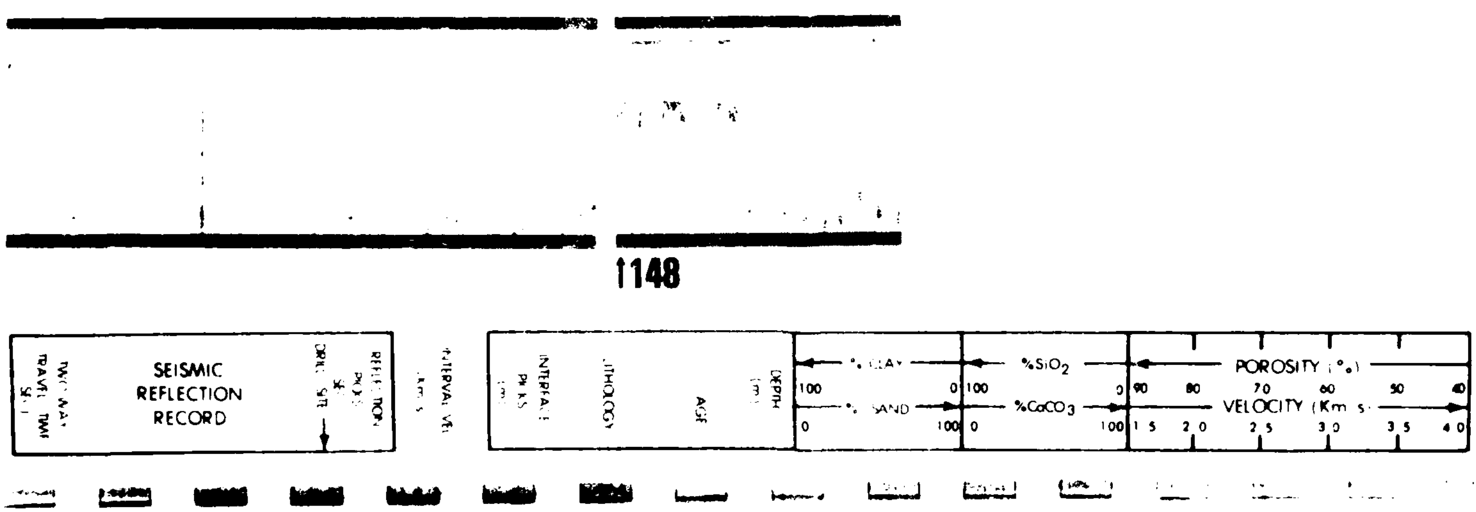
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 272 meters
Total---- 272 meters
Recovery:
Basement- cores
6.4 meters
Total---- 31 cores
181 meters

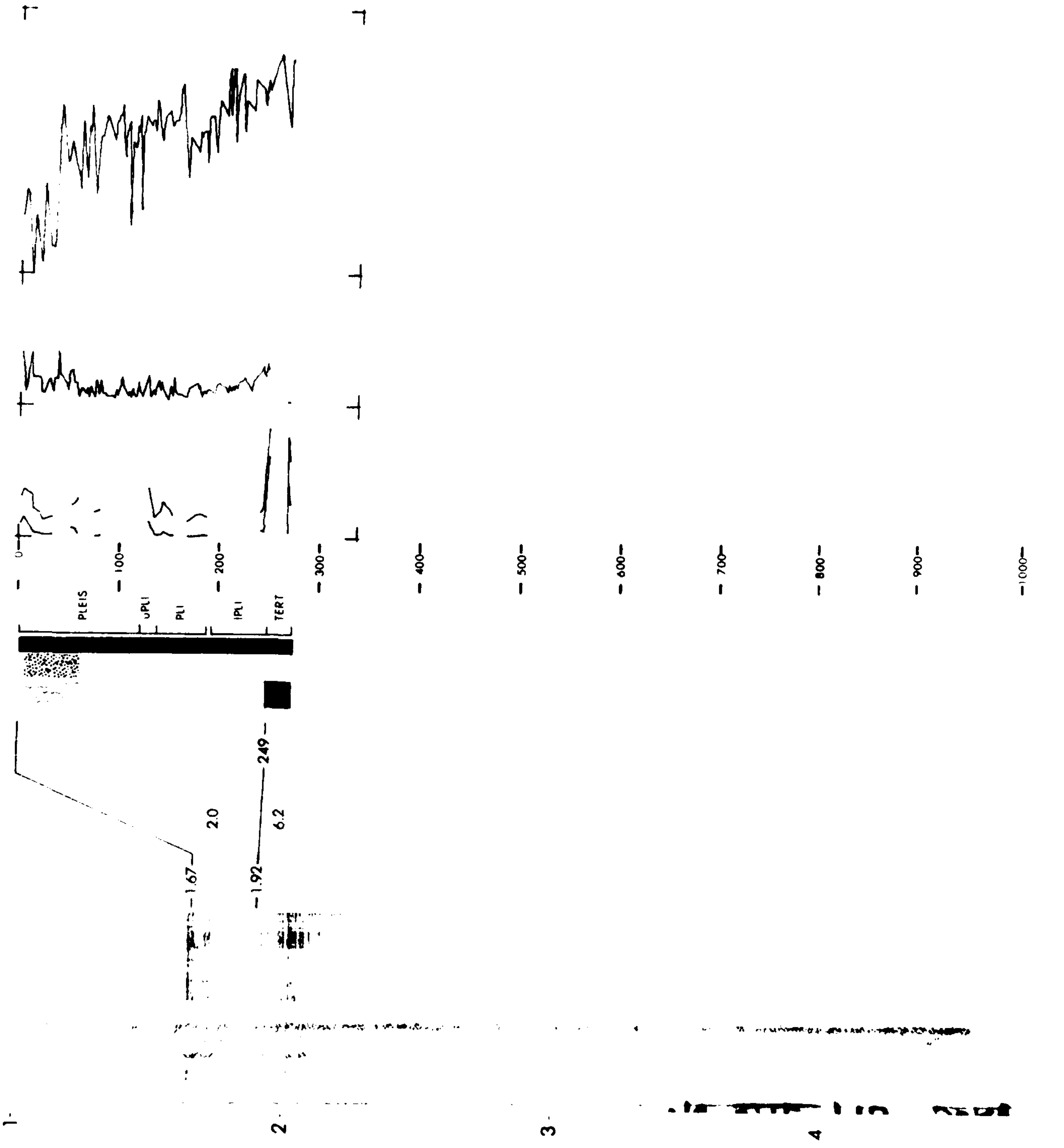
Site 148 is located on the crest of a ridge on the western margin of the Aves Ridge about 30 miles northwest of Site 30, drilled on Leg 4. The section includes [illegible]0 meters of calcareous clay of Early Pliocene to Late Pleistocene age and a basal 22-meter-thick layer of volcanic sands and clays. The lower unit contains reworked fossils that give a questionable Paleocene age. No basalt was encountered. An apparent unconformity that may reflect submarine or subaerial weathering separates the two units.

Three periods recognized are a period of relatively deep water adjacent to an emergent volcanic island (volcanic sands and clays), possibly a period in shallow water or emergent, and a final deeper stage of pelagic sedimentation (calcareous clay).

Volcanic ash layers in the mid-Pleistocene mark the initiation of intense volcanic activity in the Lesser Antilles previously inferred on geomorphic grounds.



SITE 148 LEG 15



SITE DATA

Position:
Latitude 15°06.2' N
Longitude 69°21.8' W
Date: 01/05/71
Time: 2040Z
Water depth: 3972 meters
Location: Central Venezuelan Basin

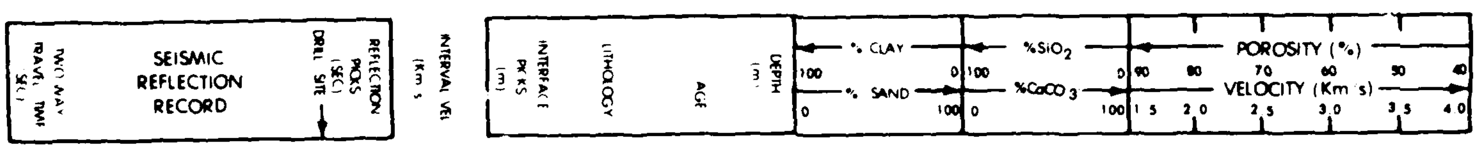
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 390 meters
Total---- 390 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 43 cores
239 meters

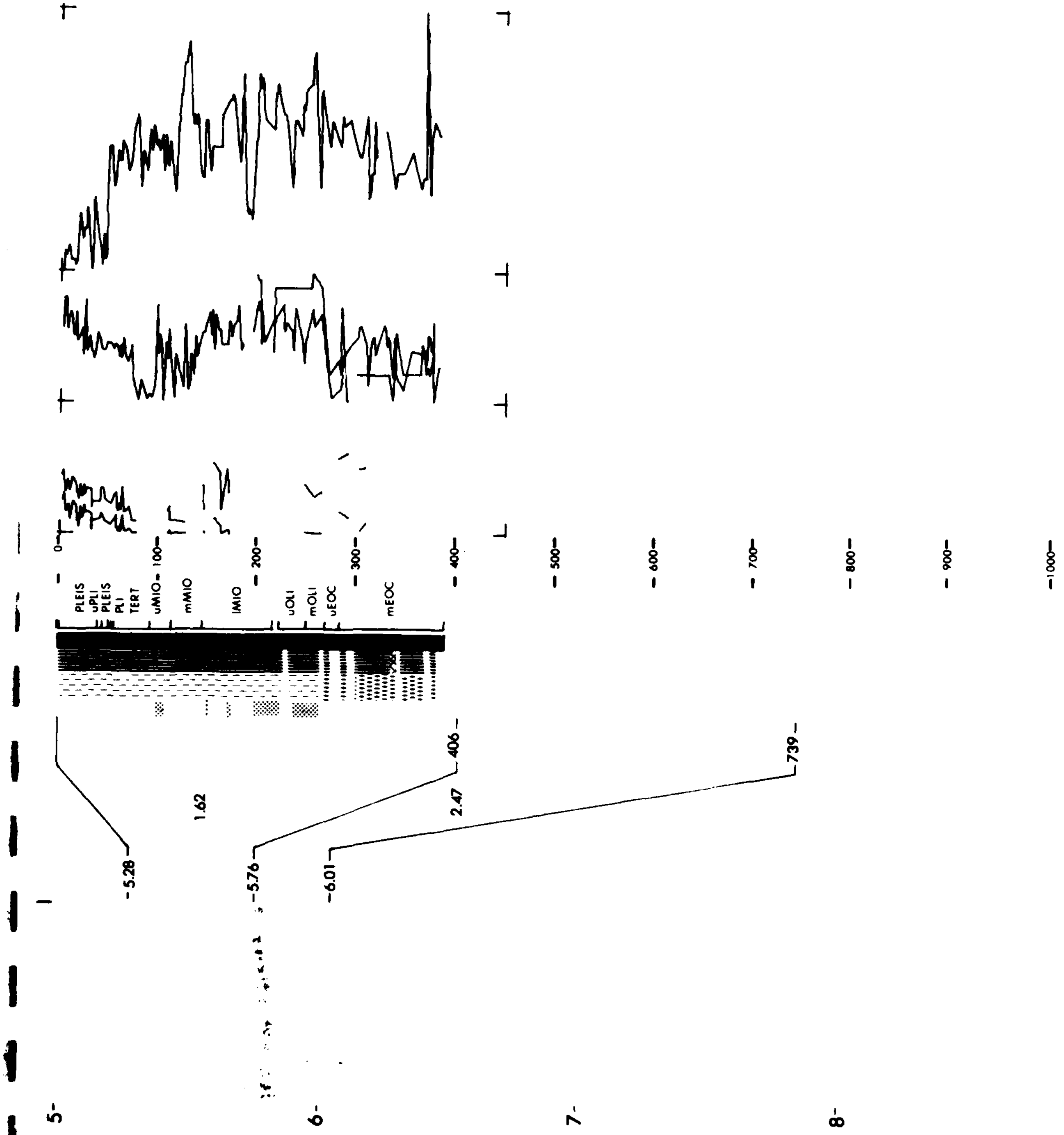
Sites 146 and 149 were drilled within 2 km of each other and are discussed together.

All sediments occasionally nannofossil rich.

149



SITE 149 LEG 15



SITE DATA

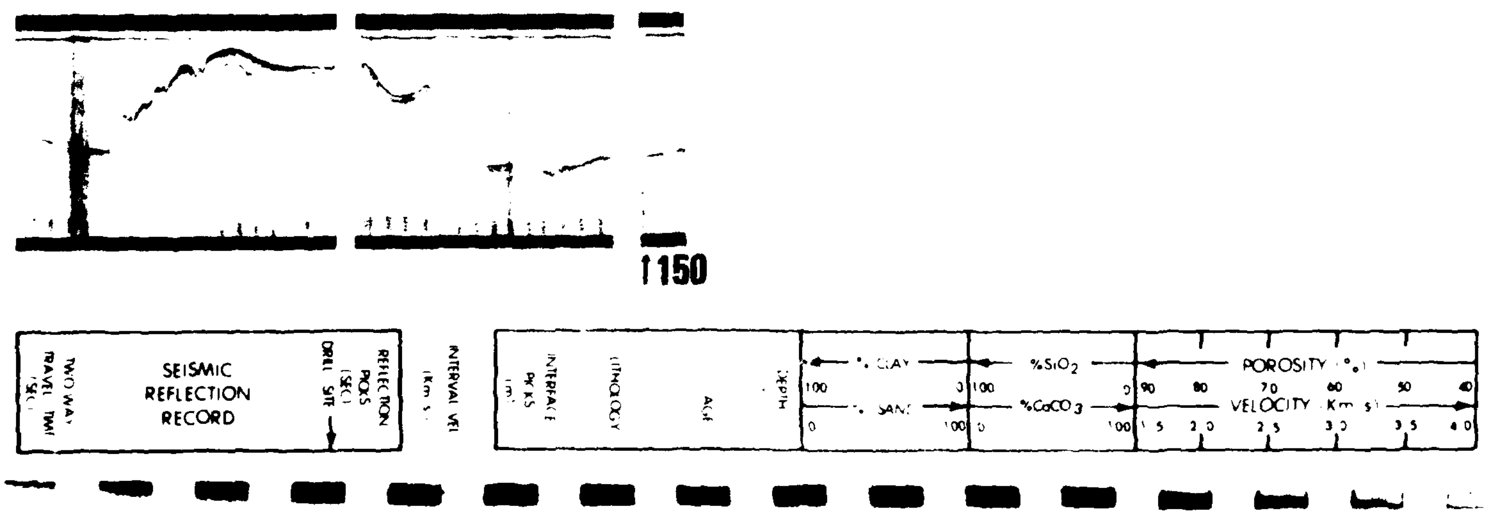
Position:
Latitude 14°30.7'N
Longitude 69°21.3'W
Date: 01/10/71
Time: 0552Z
Water depth: 4545 meters
Location: Central Venezuelan Basin

CORE DATA

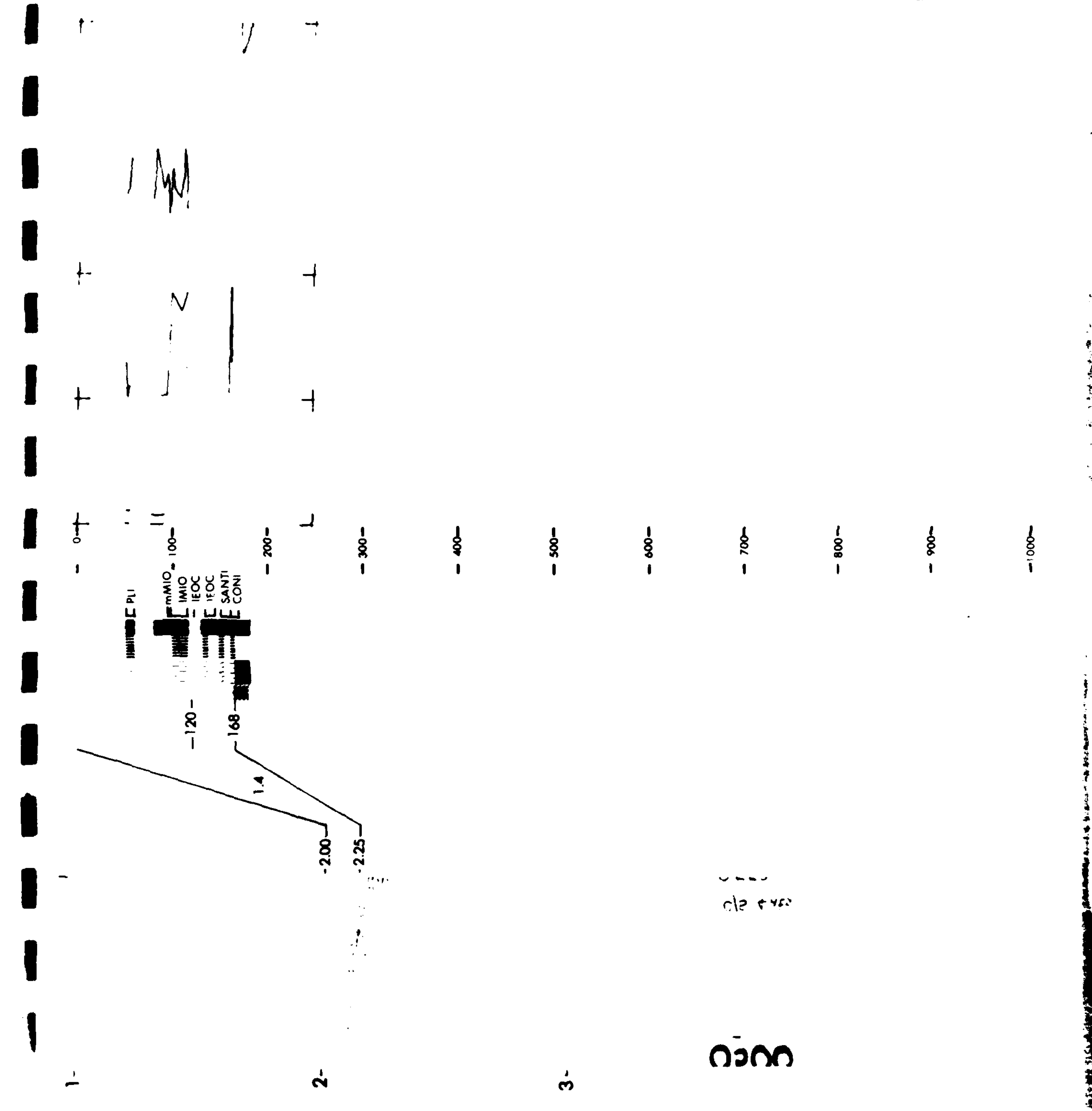
Penetration:	150	150A	
Drilled--	81	110	meters
Cored----	99	18	meters
Total----	180	128	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	12	2	cores
	39	1	meters

The extremely thin sediment cover (0.2 sec reflection time) overlying the deepest reflector (dolerite) is attributed to a hiatus in deposition during the early Tertiary and dissolution of calcium carbonate components below the depth of compensation. Late Cretaceous sediments overlying the dolerite are calcium carbonate-rich and are similar to carbonates of the same age recovered at shallower depths (Site 146/149). Cenozoic sedimentation is characterized by deposition below the calcium carbonate compensation depth. Two phases of deposition in the Cenozoic can be recognized; an early volcanic phase and, starting in the Miocene, a clay characterized by terrigenous mineralogy. Seismic reflector, Horizon A", indistinguishable from B" on the seismic records, may be represented by a thin cherty carbonate of early Eocene-Paleocene age that overlies Horizon B" dolerite by less than 60 meters.

Calcareous sediments occasionally nannofossil rich.



SITE 150 LEG 15



SITE DATA

Position:
Latitude 15°01.0' N
Longitude 73°24.6' W
Date: 01/15/71
Time: 1752Z
Water depth: 2029 meters
Location: Beata Ridge

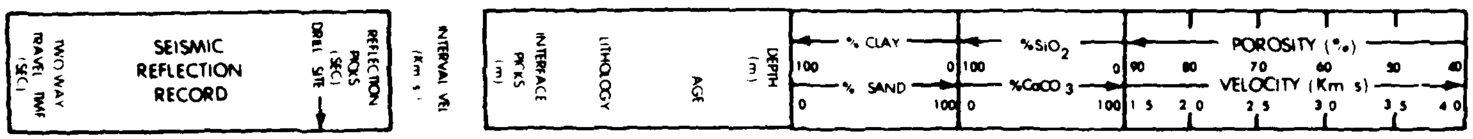
CORE DATA

Penetration:
Drilled-- 266 meters
Cored---- 155 meters
Total---- 381 meters
Recovery:
Basement- 3 cores
1.3 meters
Total---- 15 cores
56 meters

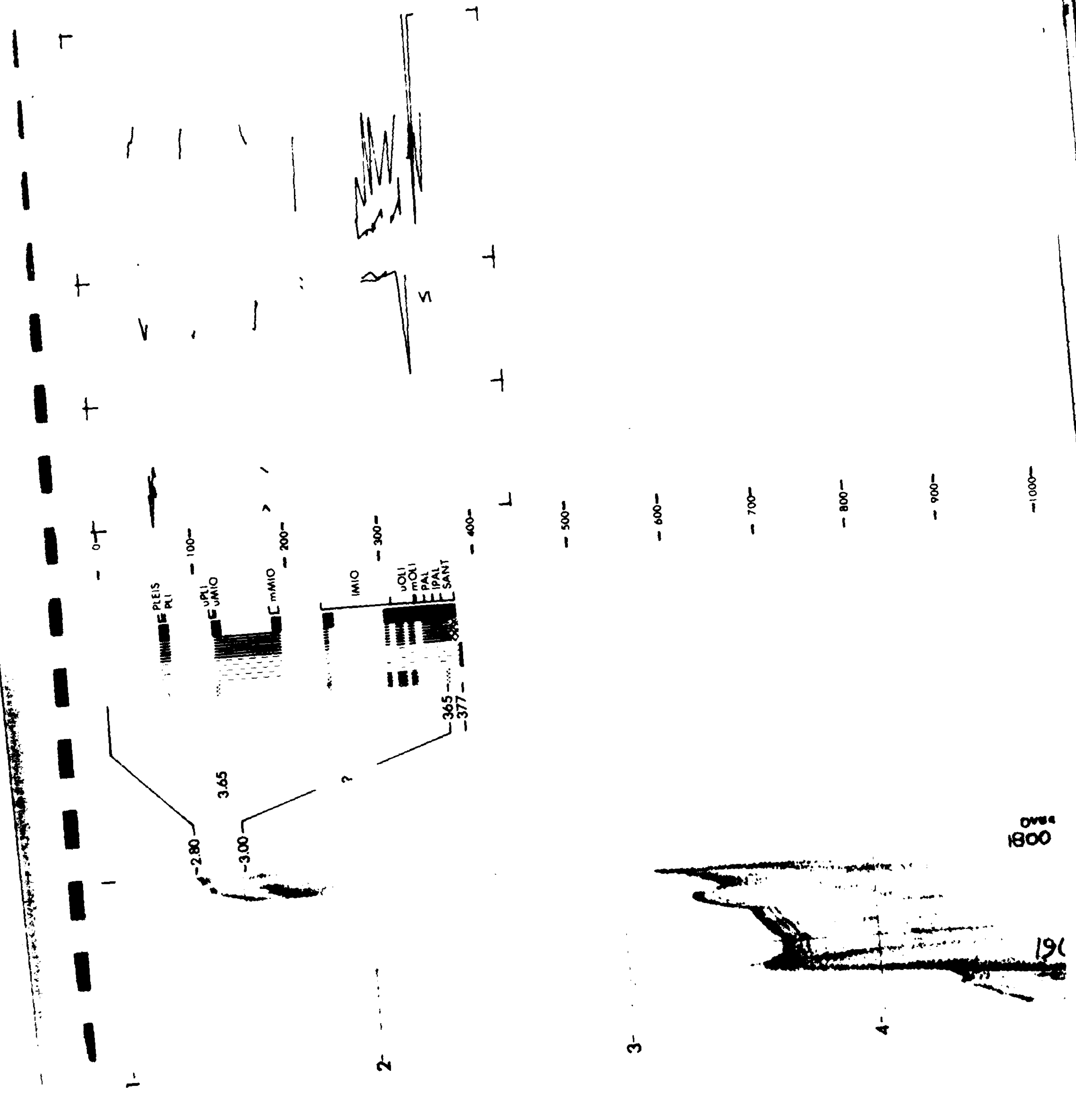
Cores at this site depict two contrasting periods of sedimentation on the southern part of the Beata Ridge. The early sediments are characterized by foraminiferal sands, volcanics, and carbonaceous clays of Santonian age and are capped by a siliceous hard ground. The hard ground marks an unconformity with Paleocene sediments overlying the Santonian (80 m.y.). The second period is represented by the overlying Tertiary pelagic sediments rich in carbonate faunal assemblages. Only fragments of the Paleocene and Eocene sequence are present. Three meters of basalt were recovered, but the contact with the overlying sediments was not recovered.

Calcareous sediments occasionally nannofossil or foraminifera (below Oligocene age) rich.

1151



SITE 151 LEG 15



SITE DATA

Position:
Latitude 15°52.7' N
Longitude 74°36.5' W
Date: 01/17/71
Time: 2000Z
Water depth: 3899 meters
Location: Nicaragua Rise

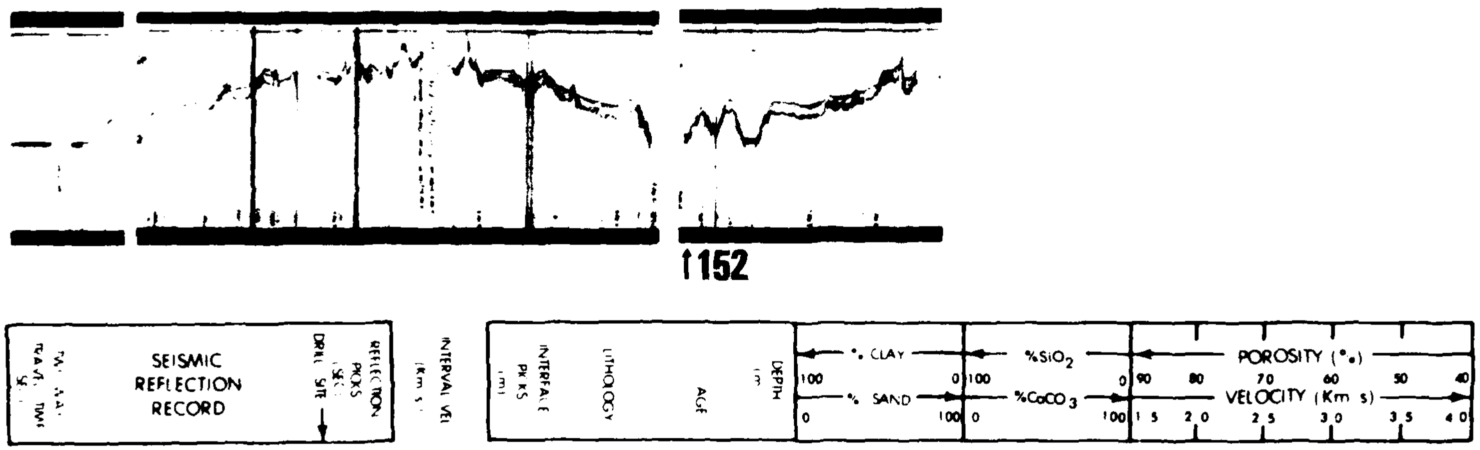
CORE DATA

Penetration:
Drilled-- 266 meters
Cored---- 211 meters
Total---- 477 meters
Recovery:
Basement- 2 cores
4.1 meters
Total---- 24 cores
59 meters

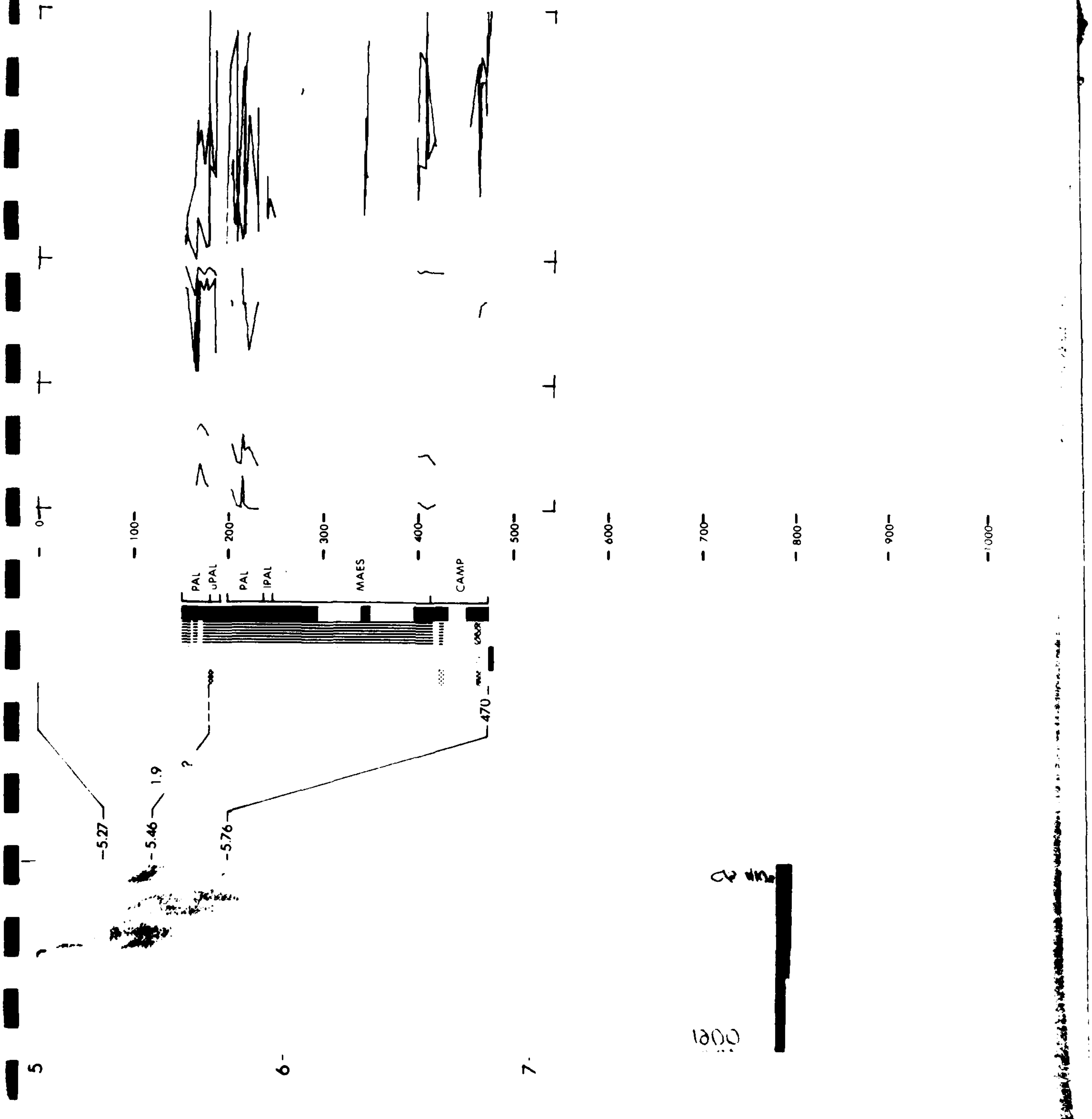
This site is located on the lower flanks of the Nicaragua Rise adjacent to the northern part of the Colombia Basin.

The entire sediment cover overlying basalt to the youngest core taken (Eocene) is all chalk and limestone of varying degrees of compaction and silicification. The prominent reflector, Horizon A", could be associated with either stiff Eocene chalks with minor cherts or with the underlying hard, partly silicified cherty Paleocene limestones. The sediment-basalt contact (Horizon B") was not recovered but large pieces of metamorphosed foraminiferal limestone were recovered below the top of the basalt.

Sediments occasionally foraminifera rich.



SITE 152 LEG 15



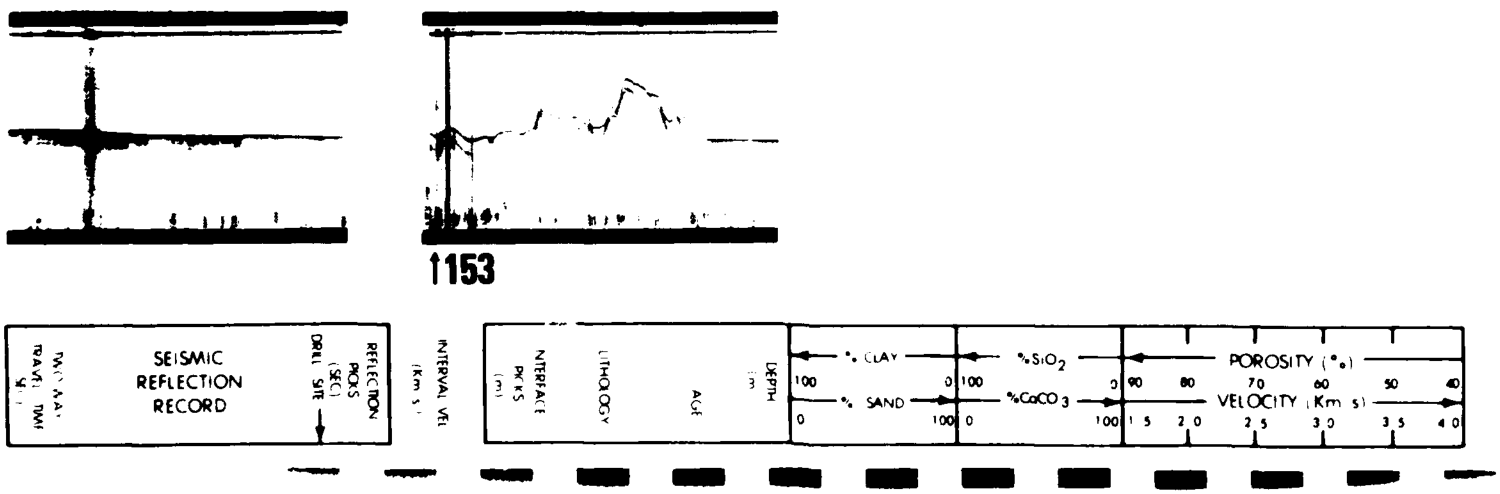
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	13°58.3' N	Drilled--	599 meters
Longitude	72°26.1' W	Cored----	177 meters
Date: 01/23/71		Total----	776 meters
Time: 1123Z		Recovery:	
Water depth: 3932 meters		Basement-	2 cores
Location: Aruba Gap			3.3 meters
		Total----	20 cores
			70 meters

This site is located in Aruba Gap, between the Beata Ridge and Venezuela where processed reflection data indicate stratified layers below Horizon B".

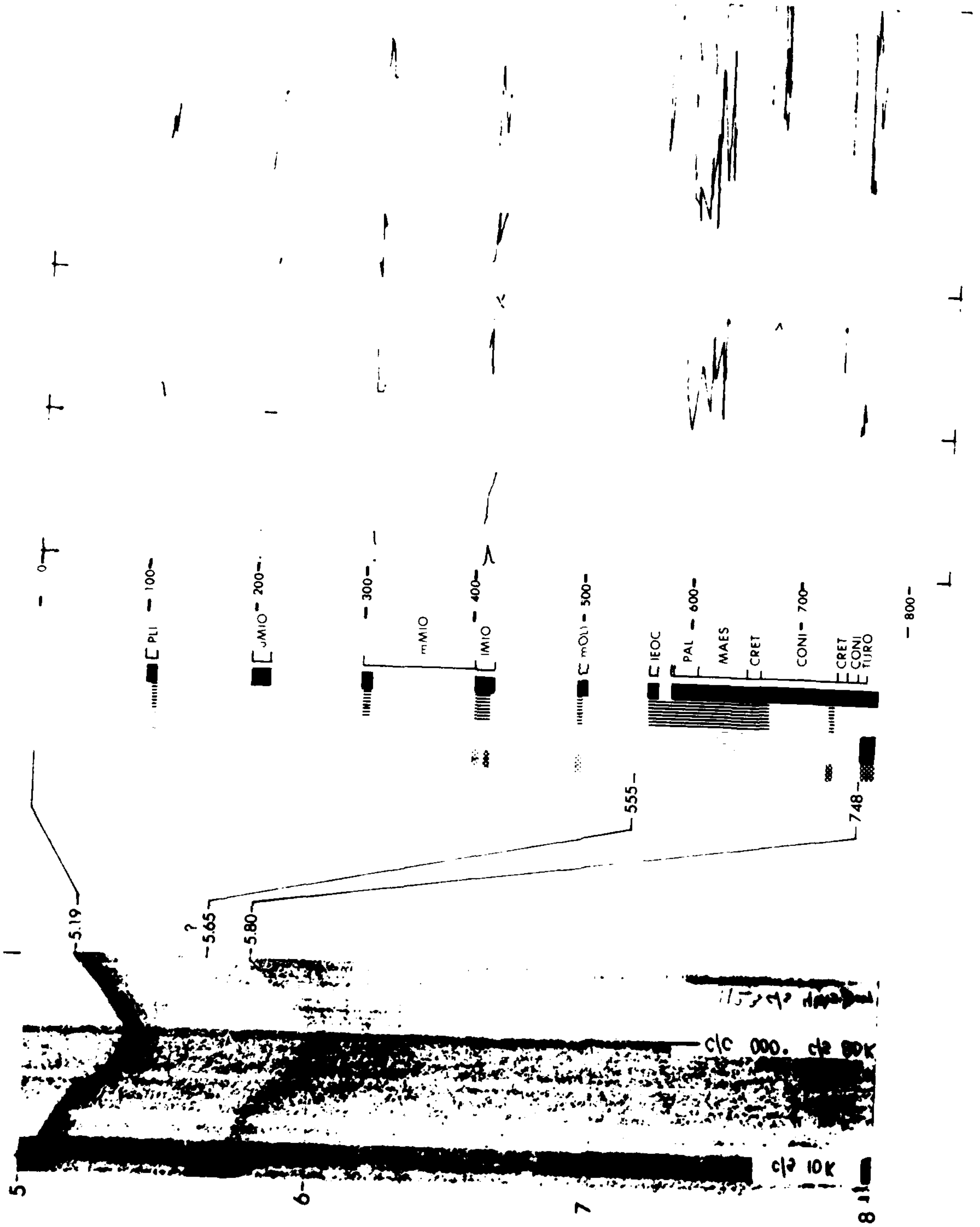
Thick soft sediments of Cenozoic age overlie hard, siliceous limestones and cherts of Early Eocene to Cretaceous (Coniacian) age. Horizon A" marks the interface between these two units. Horizon B" corresponds to a very fine-grained basalt suggestive of the top of a flow.

The limestone underlying Horizon A" is irregularly silicified and contains interlayered cherts. Interbeds of carbonaceous, phosphatic, volcanic clay are found in the lower part.

Calcareous sediments occasionally nannofossil rich.



SITE 153 LEG 15



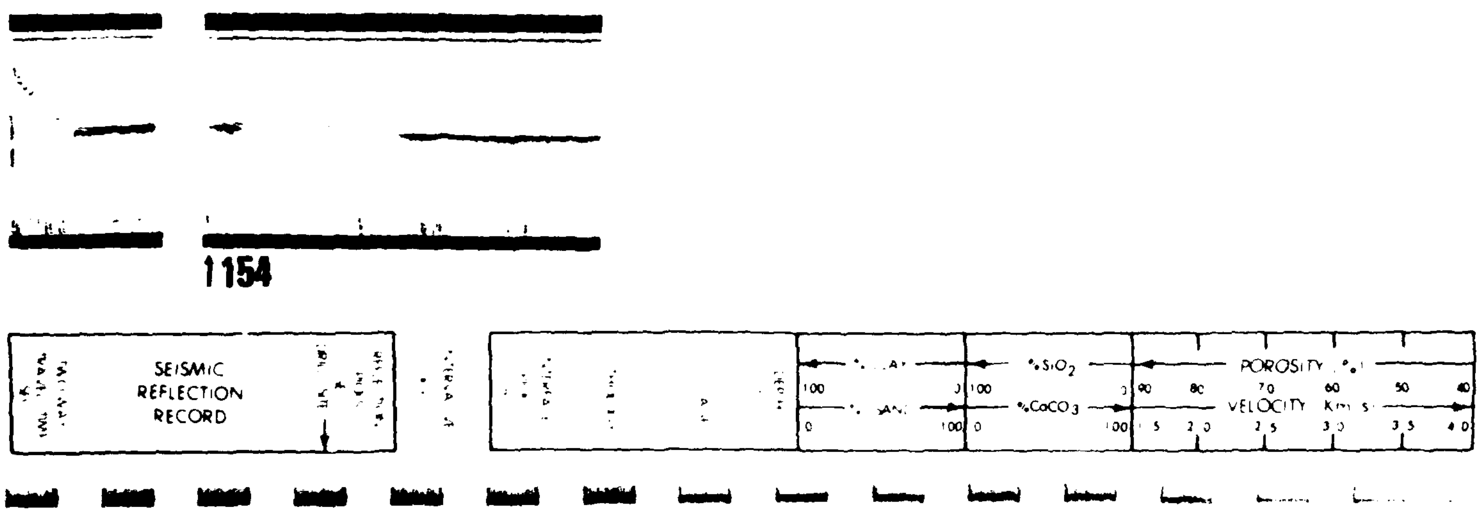
SITE DATA

Position:
Latitude 11°05.1' N
Longitude 80°22.7' W
Date: 01/29/71
Time: 1644Z
Water depth: 3338 meters
Location: Colombian Basin

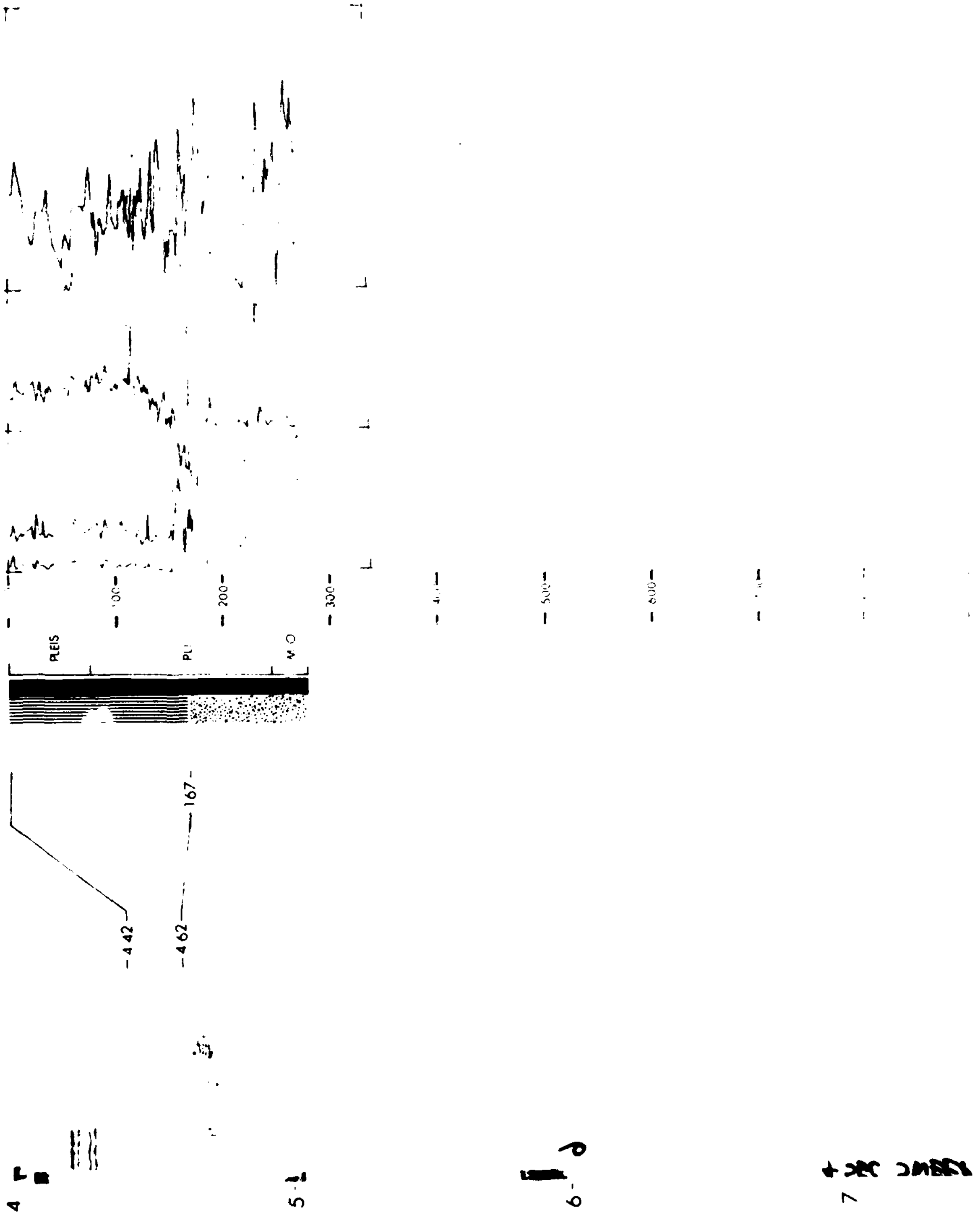
CORE DATA

Penetration:	154	154A	
Drilled--	146	1	meters
Cored----	132	171	meters
Total----	278	172	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	14	18	cores
	66	130	meters

A reflector at 0.2 sec reflection time below the crest of the ridge can be traced beneath the terrigenous sediments of the surrounding basin. The cores indicate that this reflector is associated with the abrupt transition from Middle Pliocene and younger pelagic sediments to underlying Pliocene and Miocene terrigenous sands. This transition marks the time of elevation of a ridge above the level of the surrounding ocean floor. The lower terrigenous unit is derived dominantly from calc-alkaline volcanic centers in southern Central America. The upper pelagic unit of marl and calcareous clay contains sediment probably derived from Colombia.



SITE 154 LEG 15

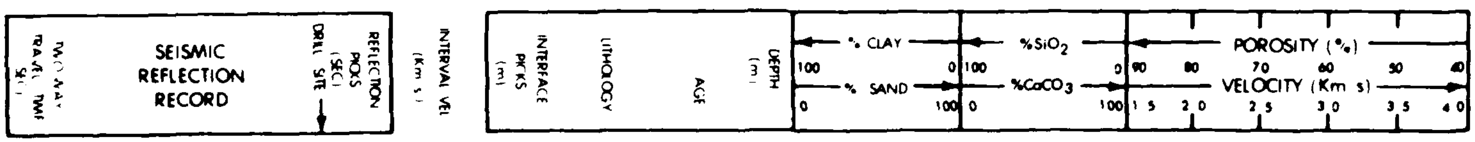


SITE DATA	
Position:	
Latitude	6°07.4' N
Longitude	81°02.6' W
Date:	02/06/71
Time:	1010Z
Water depth:	2752 meters
Location:	Coiba Ridge; eastern equatorial Pacific

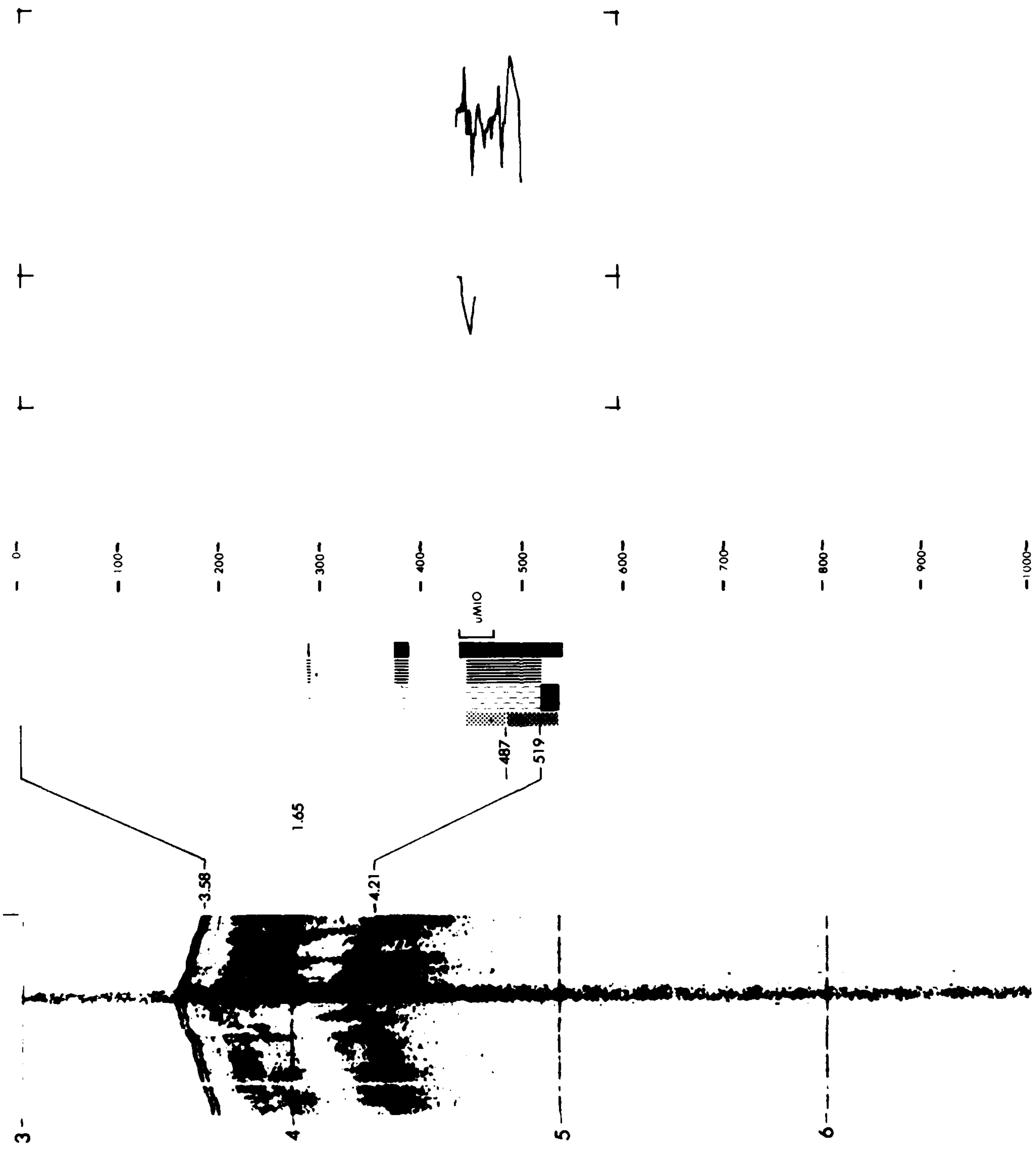
CORE DATA	
Penetration:	
Drilled--	434 meters
Cored----	102 meters
Total----	536 meters
Recovery:	
Basement-	6 cores
	1.6 meters
Total----	15 cores
	57 meters

The upper unit (434 to 484 m), of early late Miocene to middle Miocene age, consists of moderately indurated nannofossil marl and marly clay, usually with corroded or crushed microfossils, interbedded with barren waxy (bentonitic) claystone. The redistribution of opaline silica and the presence of dolomite and barite segregations points to moderately intense diagenesis of this unit. Pyrite is ubiquitous, usually as dispersed grains or stringers at lithologic contacts, but occasionally forming nodules up to 3 cm in diameter. The lowest sedimentary unit (494 to 519 m) of middle Miocene age is a nannofossil chalk, locally dolomitized and rich in altered volcanic debris. Calcareous microfossils are abundant but again are poorly preserved. Siliceous microfossils are virtually absent. Recovery of this unit was poor (probably due to alternating hard and soft layers). The basalt basement drilled comparatively easily, suggesting considerable alteration. The tendency of matrix minerals to swell in water and the presence of abundant bowlingite in thin sections confirms this suggestion. Included with the basalt are fragments of re-crystallized chalk. The absence of metasomatism in these fragments suggests that the basalt is a flow, rather than an intrusive body.

Calcareous sediments occasionally nannofossil rich.



SITE 155 LEG 16



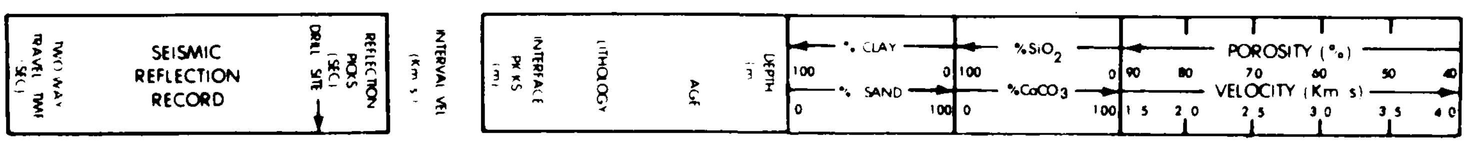
SITE DATA

Position:
Latitude 1°40.8' N
Longitude 85°24.1' W
Date: 02/12/71
Time: 0523Z
Water depth: 2369 meters
Location: Carnegie Ridge; eastern equatorial Pacific

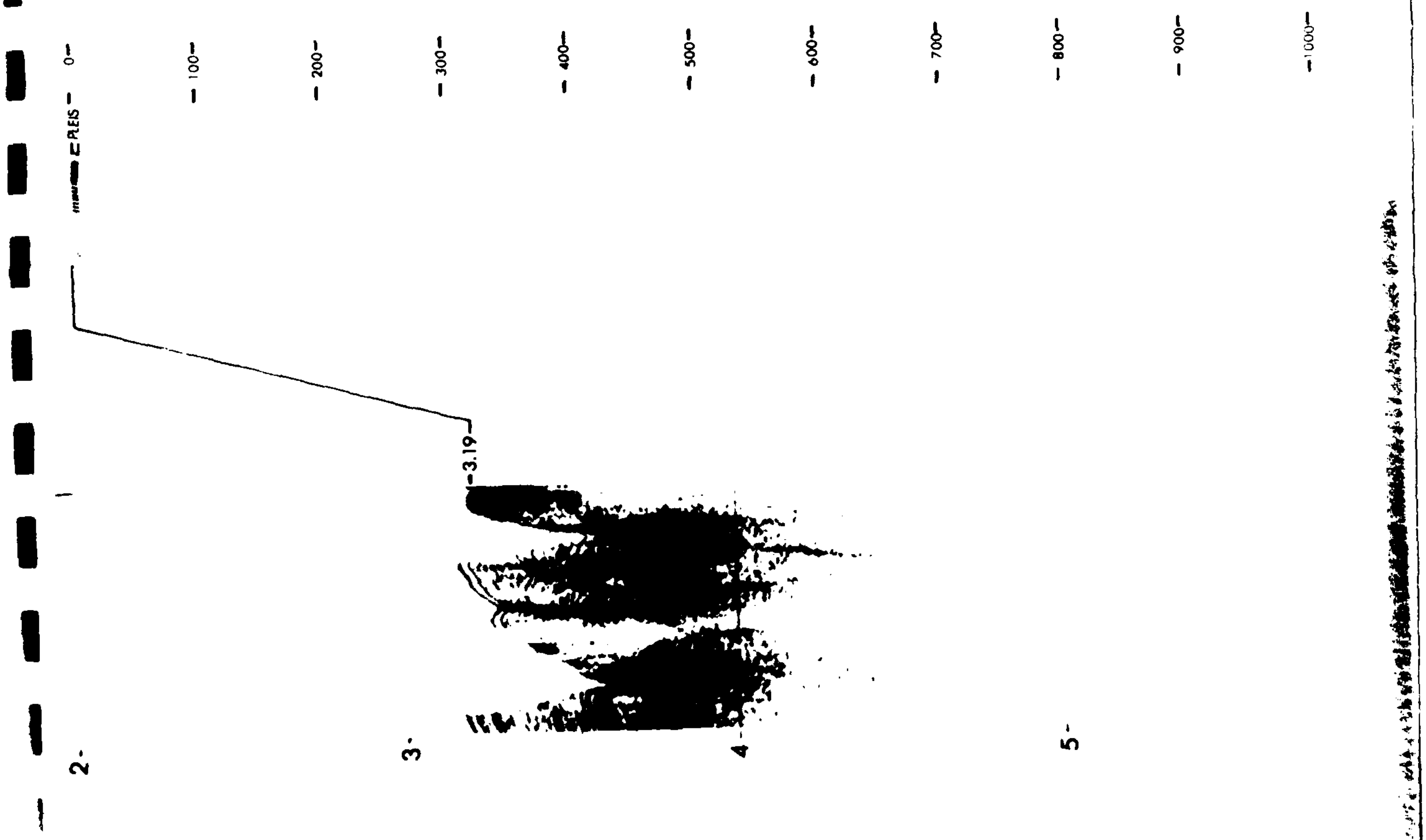
CORE DATA

Penetration:	
Drilled--	0 meters
Cored----	7 meters
Total----	4 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	2 cores
	.7 meters

The cored section consists of a winnowed pelagic ooze over a relatively undisturbed chalk ooze of Quaternary age with admixed late Tertiary components. The calcareous groups show limited diversity, pointing perhaps to selective solution, but more likely being the result of a restrictive ecologic environment in the boundary area of the equatorial current system and the Peru Current. The drill was stopped by a hard ferromanganese-oxide coating which, in all probability, is the surface of the volcanic pinnacle evident on a seismic reflection profile across the beacon site. The site survey showed clear evidence of strong downcutting erosion of the site area, resulting in the formation of deep gullies or canyons. The difference between north-south reflection profiles discussed by van Andel et al. (1971), which show no erosion, and the deeply dissected east-west profile obtained by the D/V GLOMAR CHALLENGER indicates that the erosional channels lead from the erosional area at the crest downflank to the deep Pacific basin. The present data do not permit us to establish whether this erosion is continuing at the present time or took place during the recent past.



SITE 156 LEG 16



SITE DATA

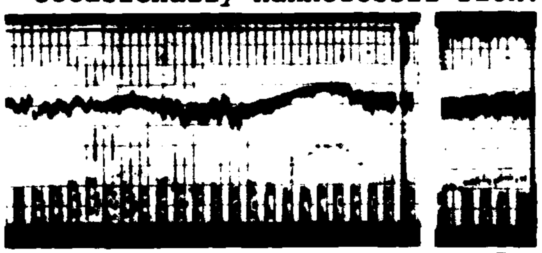
Position:
Latitude 1° 45.7' S
Longitude 85° 54.2' W
Date: 02/12/71
Time: 1010Z
Water depth: 2591 meters
Location: Carnegie Ridge; eastern equatorial Pacific

CORE DATA

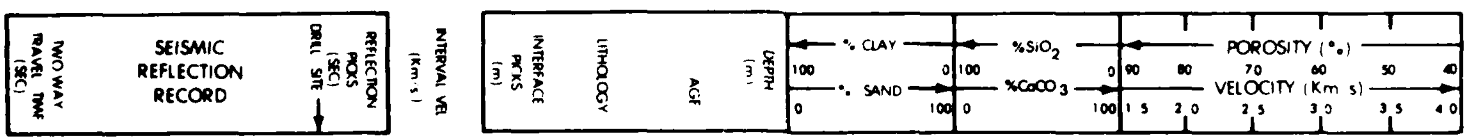
Penetration:	157	157A	
Drilled--	10	0	meters
Cored----	427	27	meters
Total----	437	27	meters
Recovery:			
Basement-	1	0	cores
	1.9	0	meters
Total----	49	3	cores
	274	19	meters

The most striking feature of the section sampled by DSDP 157 is its great uniformity, disturbed only by diagenetic changes. This must indicate very stable depositional conditions in the area, thereby strongly supporting a stable latitude for the Carnegie Ridge. The gradation from chilled margin to crystalline interior and the absence of metamorphism or metasomatism of the overlying sediments show that the basalt is a flow rather than an intrusion. The data of DSDP 157 confirm that the Carnegie Ridge has remained within the depositional regime of the equatorial current system now prevailing at the site since the inception of deposition there. The lower sedimentary sequences at this site is very nearly identical with the lowermost deposits at DSDP 155 and 158. Magnetic anomaly data indicate that the Galapagos Rift north of DSDP 157 and west of the fracture zone at 85°W was activated somewhat before anomaly 3 time or around 4 to 5 m.y. ago. It is at this point that a hiatus or highly reduced sedimentation rate is observed at DSDP 157. Thus, this break may be at least partly the result of the tectonic disturbance produced by the onset of rifting.

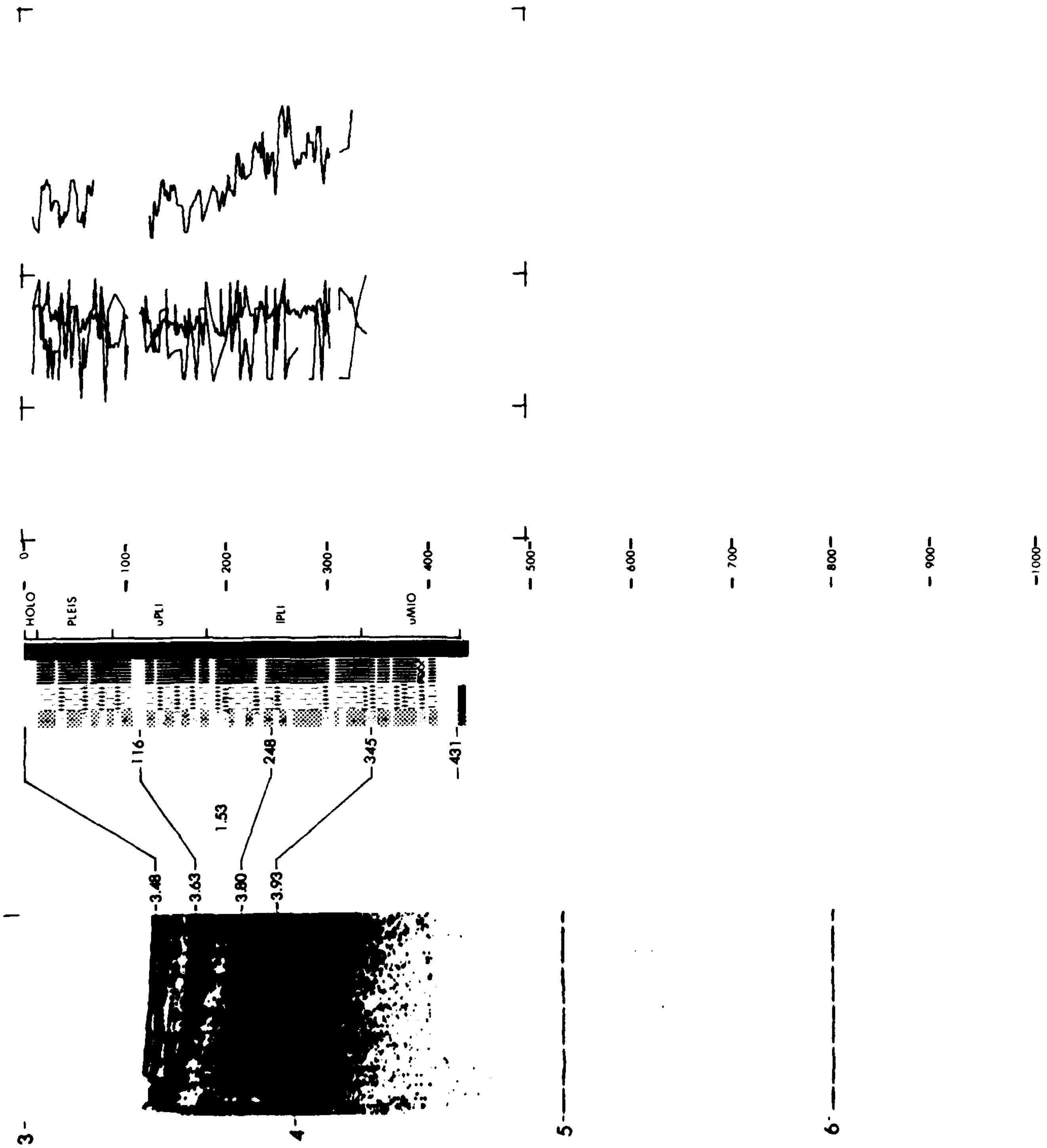
Calcareous sediments interbedded with thin siliceous layers. Calcareous sediment occasionally nannofossil rich.



↑157



SITE 157 LEG 16



SITE DATA

Position:
- Latitude $6^\circ 37.4'$ N
- Longitude $85^\circ 14.2'$ W

Date: 02/18/71
Time: 1100Z
Water depth: 1953 meters
Location: Cocos Ridge; eastern equatorial Pacific

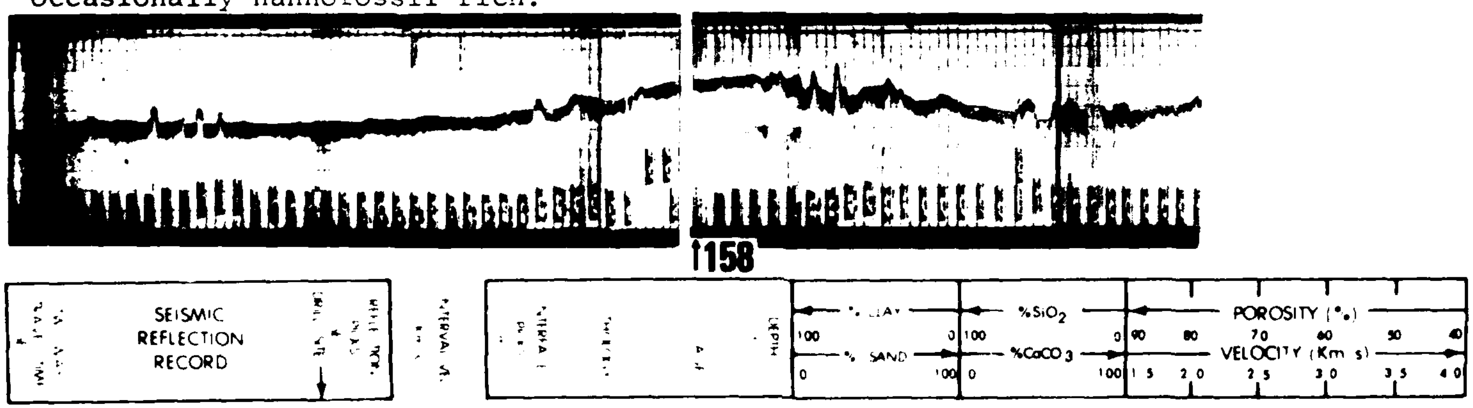
CORE DATA

Penetration:
- Drilled-- 0 meters
- Cored---- 323 meters
- Total---- 323 meters

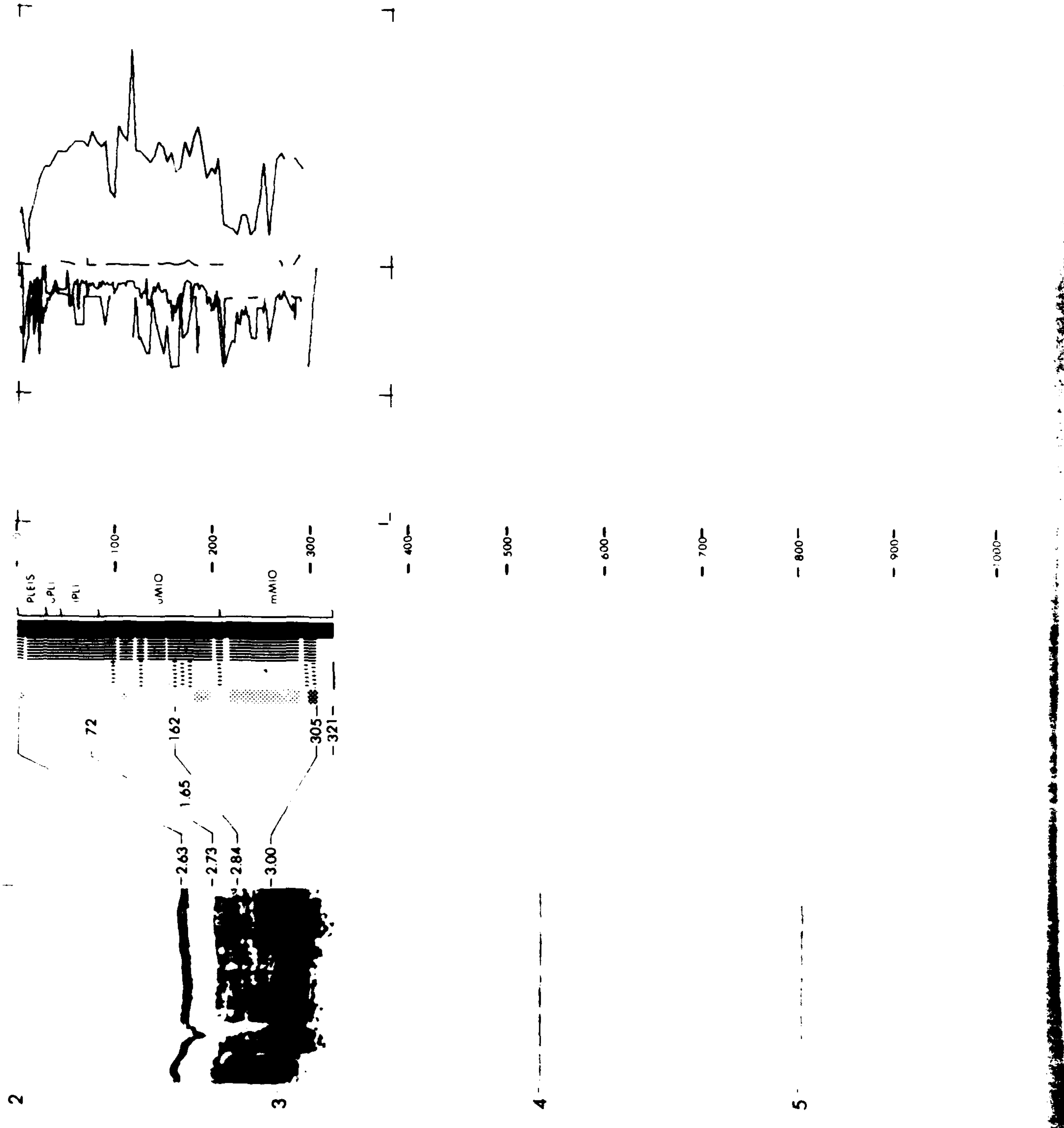
Recovery:
- Basement- 1 cores, .1 meters
- Total---- 36 cores, 250 meters

From 0 to about 30 meters, the sediment is a marly calcareous ooze rich in nannofossils and foraminifers of Quaternary age. Terrigenous detritus is prominent throughout, and volcanic ash, both dispersed and forming three well defined beds, is common. Siliceous microfossils are common, but diatoms are notably less abundant than at DSDP 157. The base of the top unit is marked by a hiatus covering most of the late Pliocene. The lithologic character of the section from 30 to 305 meters lacks abrupt changes. The sediment is chalk ooze grading to chalk over the interval 135 to 171 meters. Foraminifera are abundant at the top of the section, but decrease downward. Nannofossils are dominant throughout. Radiolaria and diatoms are of variable abundance. Below 305 meters, the chalk contains irregular masses of cristobalite and chalcedonic quartz chert. Volcanic basement at DSDP 158 consists of fine-grained augite basalt. The rock consists of labradorite laths and interstitial augite in a groundmass of spherulitic ?chlorite (probably altered glass). As with the other Panama Basin sites, the lack of evidence for metasomatism and metamorphism of the overlying sediments, and the texture of the basalt point to an extrusive rather than intrusive origin for the volcanic basement.

Calcareous sediments interbedded with thin layers of siliceous beds. Sediments occasionally nannofossil rich.



SITE 158 LEG 16



SITE DATA

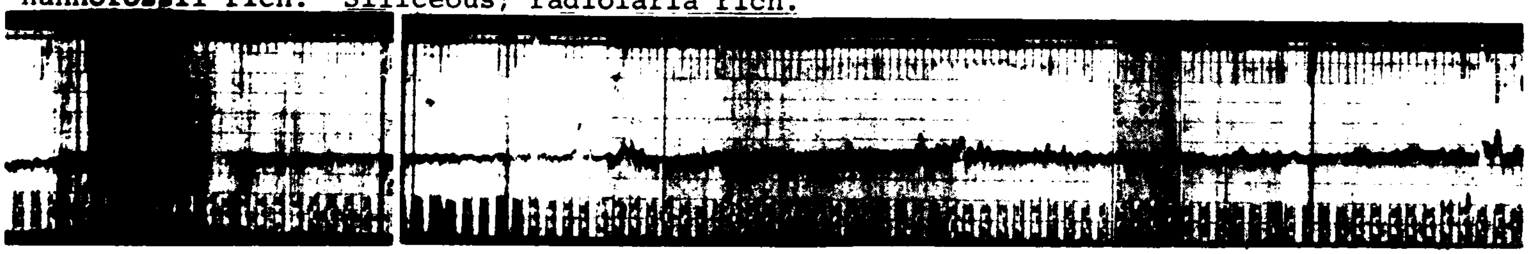
Position:
Latitude $12°19.9'$ N
Longitude $122°17.2'$ W
Date: 03/01/71
Time: 1400Z
Water depth: 4484 meters
Location: West flank of East Pacific Rise

CORE DATA

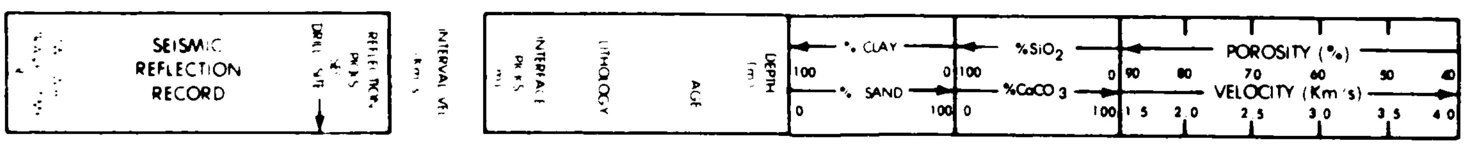
Penetration:		
Drilled--	0	meters
Cored----	109	meters
Total----	109	meters
Recovery:		
Basement-	1	cores
	.1	meters
Total----	14	cores
	97	meters

From 0 to 18 meters, the sediment is somewhat siliceous pelagic brown clay, rich in dispersed ferromanganese oxides. The abrupt increase in the sedimentation rate at the end of the Tertiary, may be accentuated by one or more hiatuses, is common in the North Pacific. From 18 to 71 meters, the sediment changes gradually from calcareous clay with some pelagic brown clay and nannofossil marl to nannofossil marl with subordinate calcareous clay. In contrast to the lithology, both the physical properties and the micropaleontological data indicate a change in character at about 47 meters, pointing to a brief hiatus in the late early Miocene. The lowest portion of the sediment section is a fairly uniform nannofossil marl ooze rich in dark brown ferromanganese aggregates. These aggregates are most abundant just above basement and appear to represent the local equivalent of the "amorphous iron-oxide facies" reported for Legs 5 and 9. Volcanic basement at the site is a fine-grained altered augite-plagioclase basalt. The samples recovered were originally vesicular and probably glassy so that an extrusive orgin is inferred. Such an origin is supported by the absence of evidence of metasomatism and metamorphism of the overlying sediments.

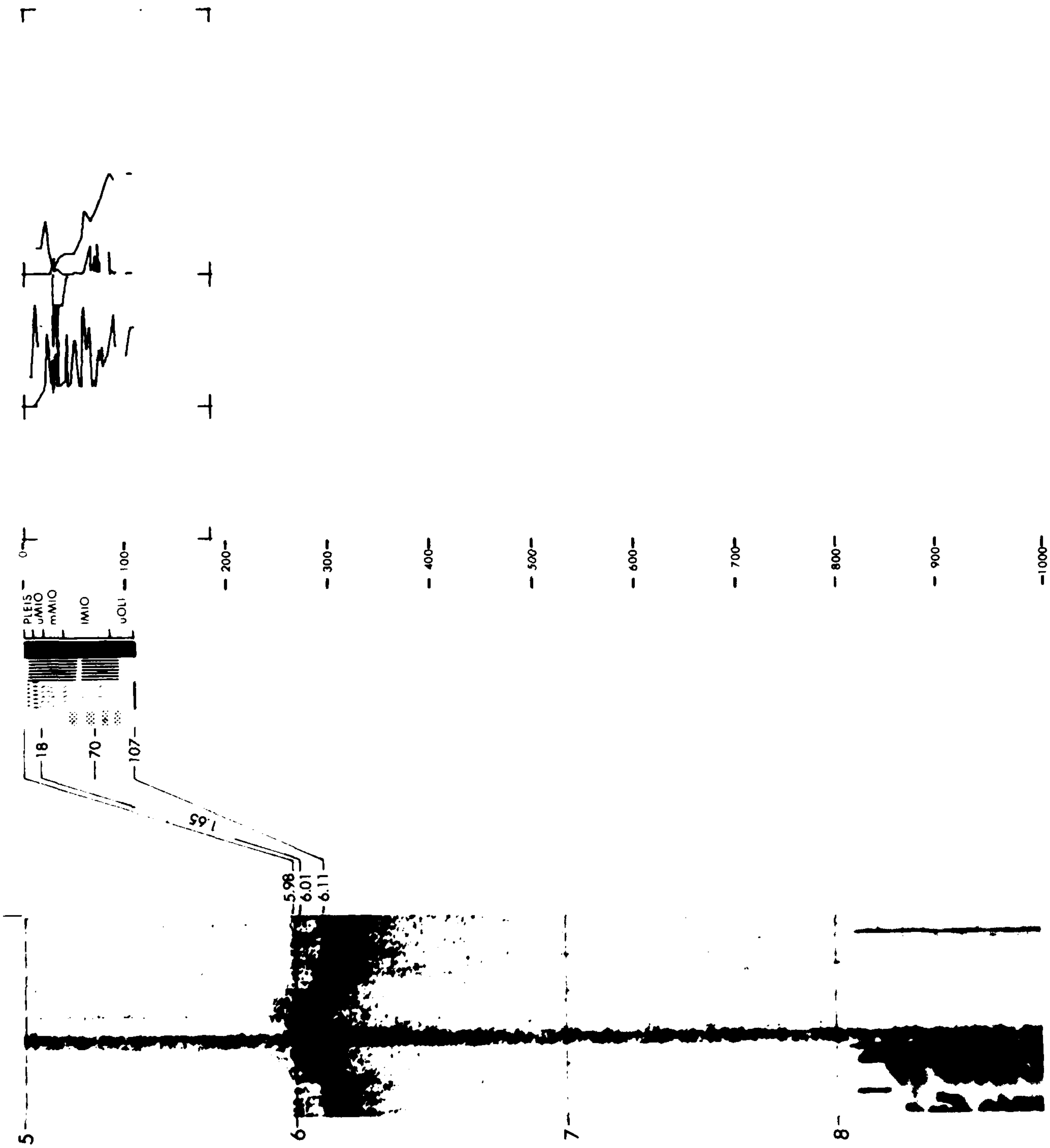
Sediments interbedded calcareous, siliceous, and detrital, thin layers. Calcareous; nannofossil rich. Siliceous; radiolaria rich.



1159



SITE 159 LEG 16



SITE DATA

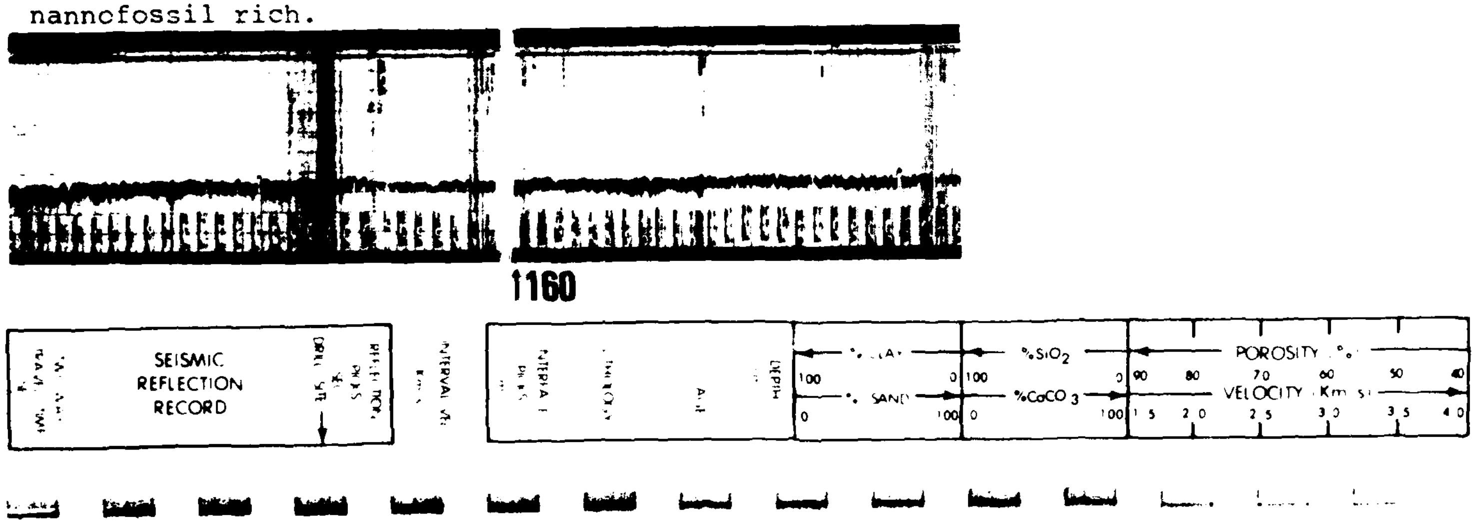
Position:
Latitude 11°42.3' N
Longitude 130°52.8' W
Date: 03/05/71
Time: 1430Z
Water depth: 4940 meters
Location: West flank of East Pacific Rise

CORE DATA

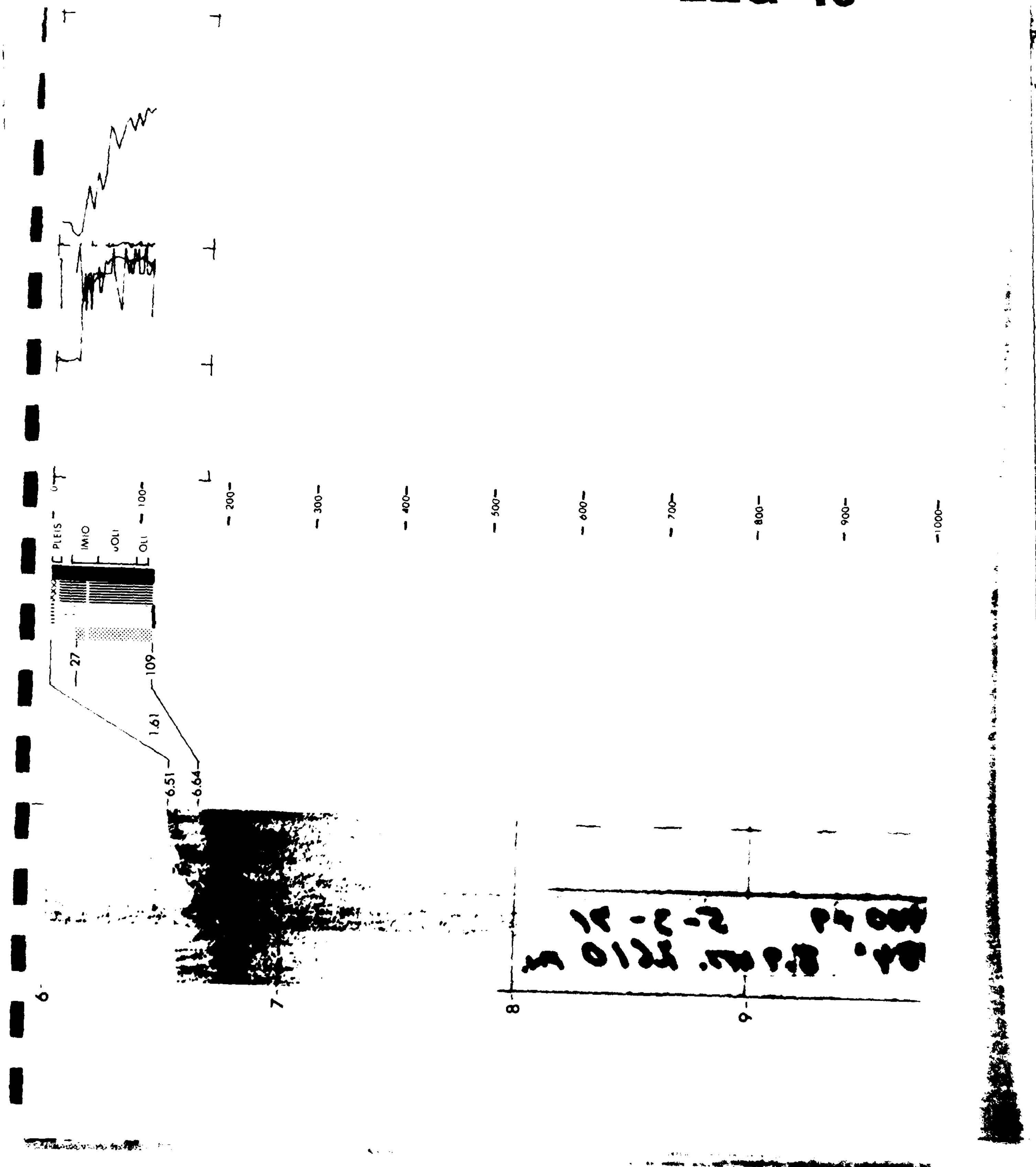
Penetration:
Drilled-- 0 meters
Cored---- 114 meters
Total---- 114 meters
Recovery:
Basement- 1 cores
.01 meters
Total---- 14 cores
96 meters

From 0 to 27 meters, the sediment is brown zeolitic clay containing ferromanganese nodules and fine, ferruginous-looking aggregates. Large manganese nodules in the interval are probably due to caving from the surface. From 27 to 108 meters, the sediment is a grayish orange to very pale orange nannofossil chalk ooze, locally grading to marl ooze. Radiolarians are present throughout, but foraminifers are restricted to the interval 36 to 108 meters and are poorly preserved. The sediment was apparently laid down between the lysocline and the calcite compensation depth, a conclusion supported by the low sedimentation rate of 5 m/m.y. yrs from 18 to 34 m.y. The absence of the Dictyococcites abisectus Subzone points to a disconformity at about 43 meters (Oligocene-Miocene boundary). Just above basement, from 108 to 109 meters, the core is severely disturbed with cavings from above and cuttings from the underlying basalt, contaminating the dark brown calcareous clay, rich in ferruginous micro-aggregates, that represents the basal "amorphous iron-oxide" facies. Basement is a fine-grained extrusive basalt, containing labradorite and augite microphenocrysts and magnetite grains in an altered groundmass that was probably once glass.

One thin bed of siliceous sediment occurs in Pleistocene time. Sediments occasionally nannofossil rich.



SITE 160 LEG 16



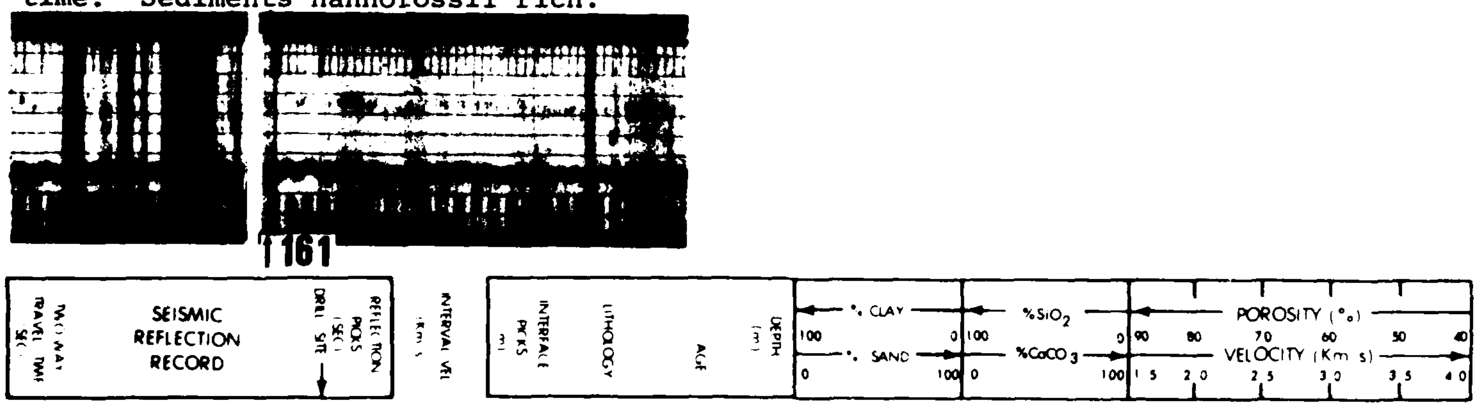
SITE DATA

Position:
Latitude $10^\circ 40.2' N$
Longitude $139^\circ 57.3' W$
Date: 03/09/71
Time: 2230Z
Water depth: 4939 meters
Location: West flank of East Pacific Rise

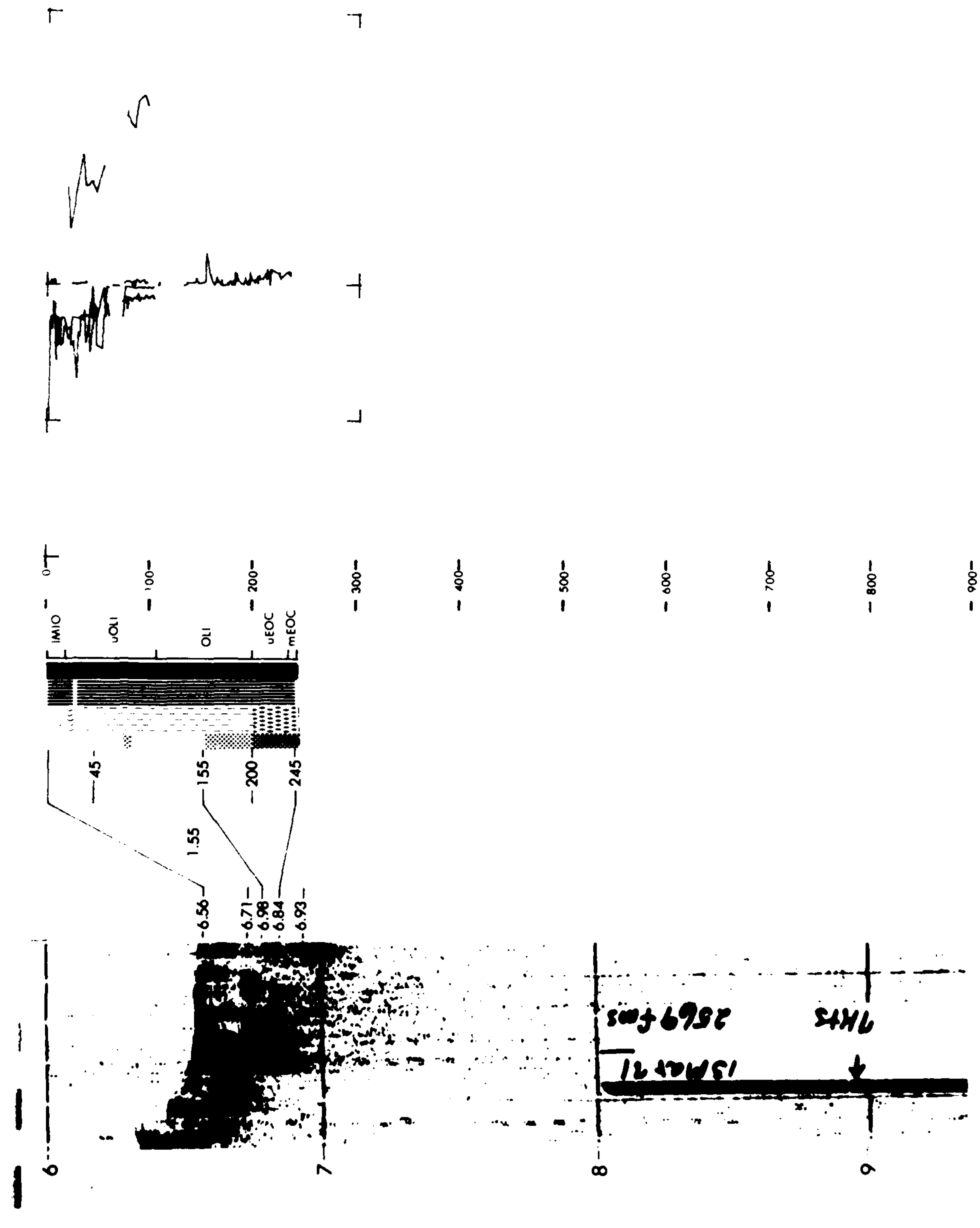
CORE DATA

Penetration:	161	161 A	
Drilled--	0	119	meters
Cored----	126	126	meters
Total----	126	245	meters
Recovery:			
Basement-	0	1	cores
	0	.1	meters
Total----	14	15	cores
	94	88	meters

From 0 to 2 meters, the sediment is highly porous brown radiolarian clay, mostly of early Miocene age but containing a few Quaternary radiolarians at the surface. From 2 to 45 meters the sediment is mottled pale orange and grayish orange nannofossil chalk ooze. Although calcareous, these sediments lack foraminifera, suggesting severe dissolution before burial. From 45 to 155 meters, the sediment is nannofossil chalk ooze mostly very uniform white in color. Despite the high carbonate content of the unit, foraminifers are rare and poorly preserved. Apparently, the sea floor at the site has never been shallower than the lysocline. Below 130 meters, the chalk ooze becomes more indurated with depth. The deepest sediment, from 200 to 244 meters, is dark yellow brown clayey indurated radiolarian ooze of early and middle Eocene age. This sediment is clayey, intensely mottled, and rich in ferruginous aggregates. The clay is more porour (about 75%) and has a higher natural gamma activity than the overlying chalk. Measured acoustic velocities show considerable scatter but generally increase from 1.52 to 1.62 km/sec from the top to the bottom of the radiolarian ooze. The Thyrsocyrtis tetracantha (radiolarian) zone is absent, possibly suggesting a brief hiatus between the middle and late Eocene. The sedimentation rate is about 5 m/m.y. Basement at DSDP 161 is extrusive basalt. Rock was originally glassy and vesicular, with microphenocrysts of olivine, augite, and calcic. One thin bed of detrital sediment occurs in Lower Miocene time. Sediments nannofossil rich.

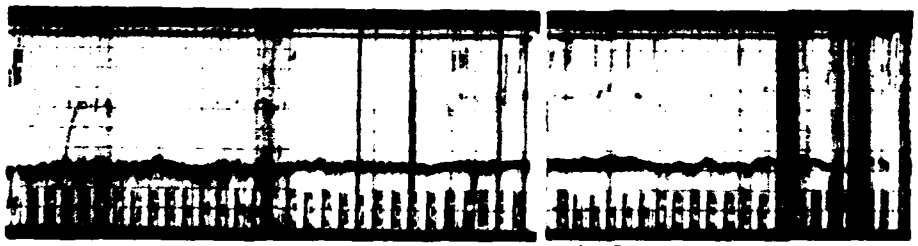


SITE 161 LEG 16

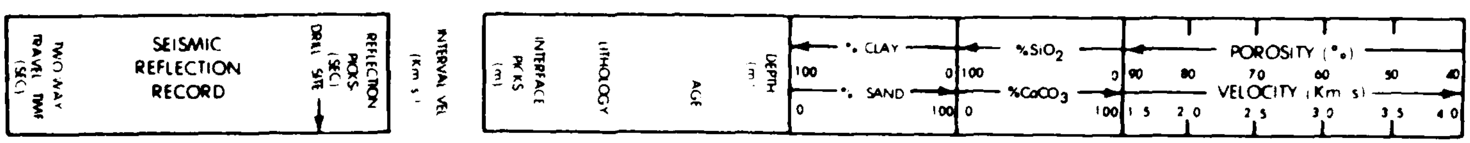


SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	14°52.2' N	Drilled--	0 meters
Longitude	140°02.6' W	Cored----	153 meters
Date:	03/15/71	Total----	153 meters
Time:	0700Z	Recovery:	
Water depth:	4854 meters	Basement-	1 cores
Location:	West flank of East Pacific Rise		.01 meters
		Total----	17 cores
			132 meters

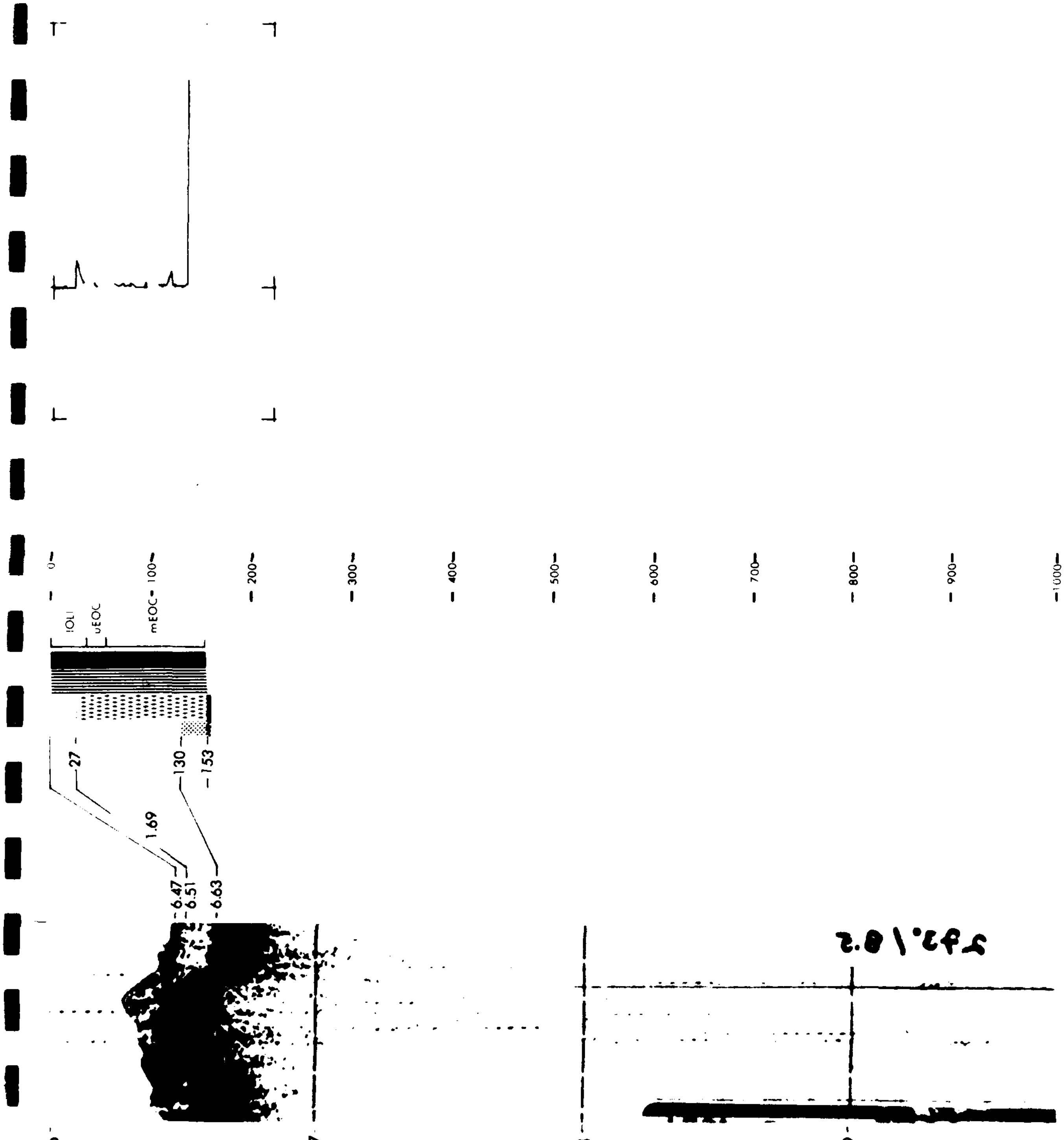
The top 26 meters, of Oligocene age, consist of interbedded nannofossil chalk ooze and subordinate brown clayey radiolarian ooze and brown clay with ferromanganese nodules. From 26 to 63 meters, the sediment is brown clayey radiolarian ooze of late Eocene and earliest Oligocene age. The upper ten meters are sparsely calcareous. The absence of the Thyrsocyrtis tetracantha (radiolarian) zone could indicate a brief hiatus in the late Eocene. The accumulation rate for the radiolarian ooze section is 3 m/m.y. From 63 to 140 meters, the section is mainly clayey radiolarian nannofossil marl ooze with lesser chalk ooze and brown clayey radiolarian ooze. The lowest sedimentary unit, is mostly ferruginous zeolitic brown clay, but includes a basal foraminiferal nannofossil chalk about 49 m.y. old. This chalk contains the only good foraminiferal assemblage at the site. The basal chalk rests on heavily altered brown basalt, which is glassy and contains bytownite and rare augite microphenocrysts. The absence of evidence for metamorphism or metasomatism in the overlying chalk indicates an extrusive origin.



1162



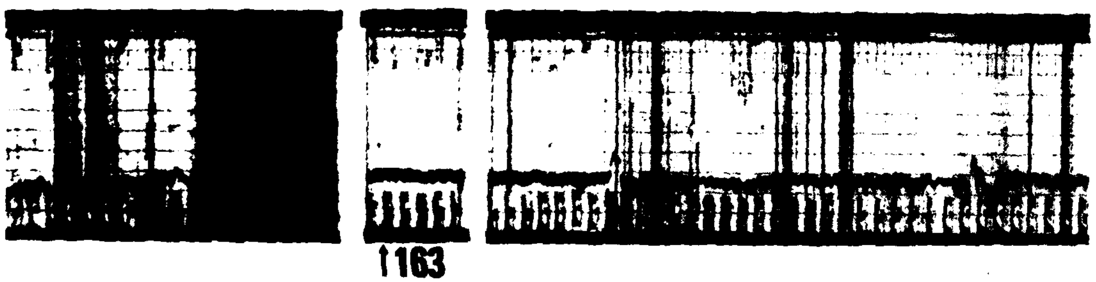
SITE 162 LEG 16

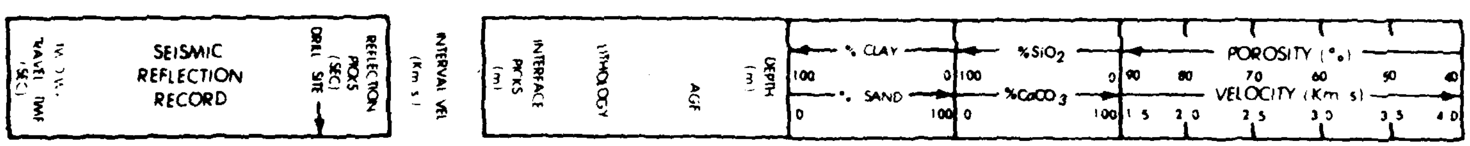


SITE DATA	
Position:	
Latitude	$11^{\circ}14.7'$ N
Longitude	$150^{\circ}17.5'$ W
Date:	03/20/71
Time:	1115Z
Water depth:	5320 meters
Location:	Abyssal hill area between Clipperton and Clarion fracture zones

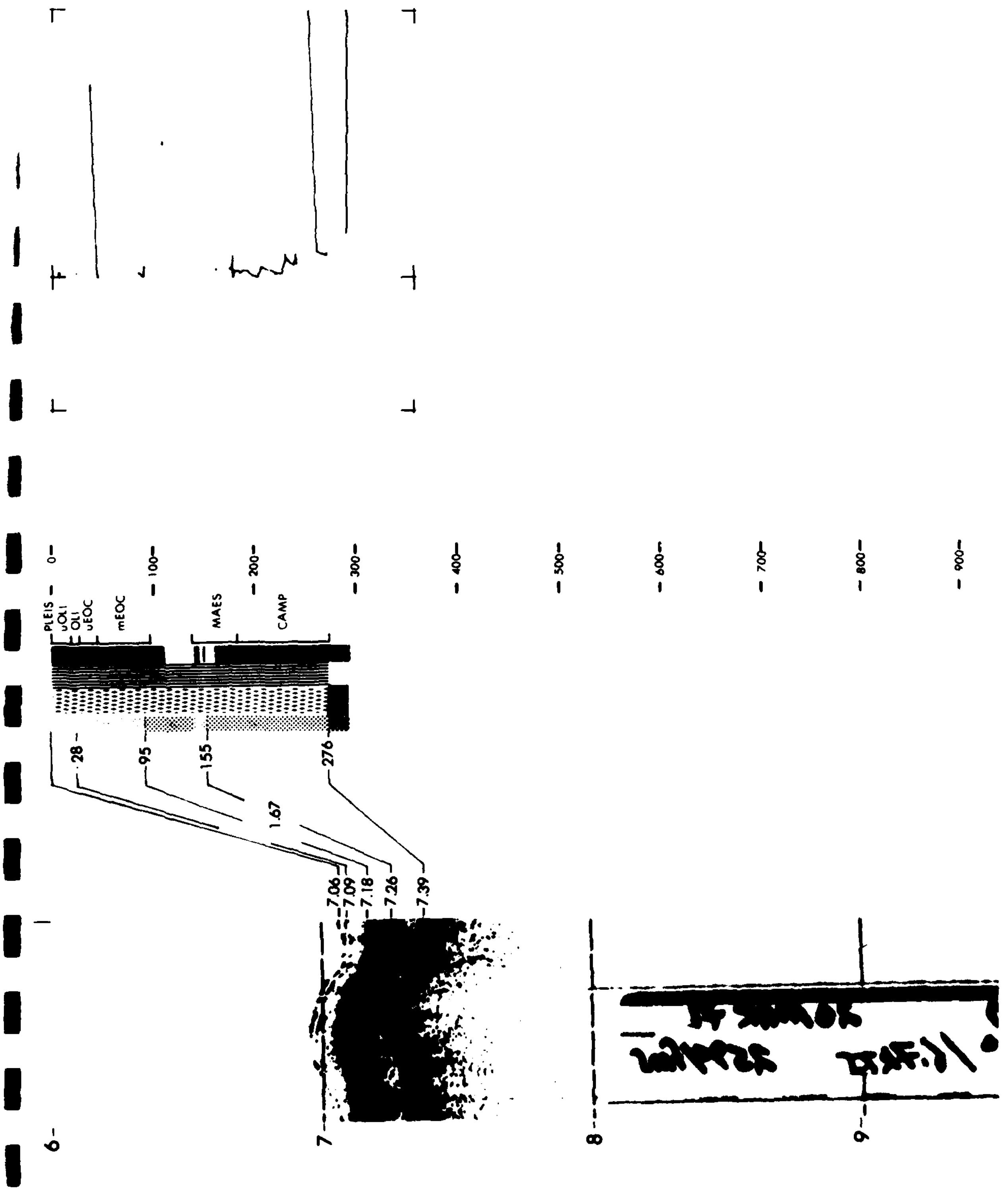
CORE DATA	163	163A	
Penetration:			
Drilled--	51	146	meters
Cored----	243	5	meters
Total----	294	151	meters
Recovery:			
Basement-	2	0	cores
	7.4	0	meters
Total----	29	2	cores
	156	5	meters

The top 28 meters of the section consist of slightly radiolarian zeolitic brown clay, becoming more radiolarian-rich and less zeolitic with depth. From 28-95 meters, the sediment is clayey, brown radiolarian ooze of middle and late Eocene age. Scattered through the unit are thin beds of porcellaneous brown chert. The youngest of these is at the Eocene-Oligocene boundary. The absence of the Thyrsocyrtis tetracantha and Podocyrtis geotheana radiolarian zones points to a hiatus between the middle and late Eocene sections, a conclusion supported by reworked forms above this boundary. The presence of a few calcareous nannofossils at the base of the clay unit suggests that in the early Maestrichtian the site lay precisely at the calcite compensation depth. The Cretaceous-Tertiary boundary was not sampled. The nature of the deepest Eocene sediments suggest that the 20 m.y. gap is too large for the 40 meters of missing section, indicating a possible hiatus. From about 150 to 276 meters, the sediment is nannofossil chalk. It appears to have been laid down between the contemporary lysocline and calcite compensation depth. The chalk overlies extrusive basalt, belonging to at least seven flow units, each bounded by glassy margins.





SITE 163 LEG 16

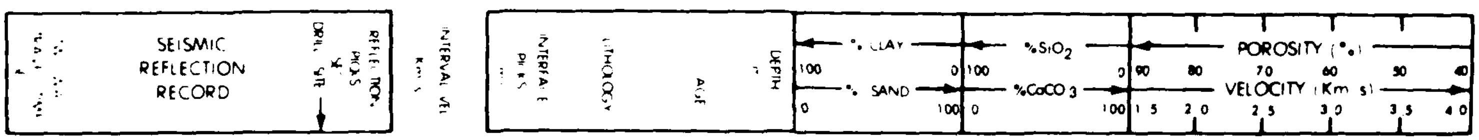


SITE DATA	
Position:	
Latitude	13°12.1' N
Longitude	161°31.0' W
Date:	04/06/71
Time:	1300Z
Water depth:	5485 meters
Location:	Between Line Island chain and Hawaii

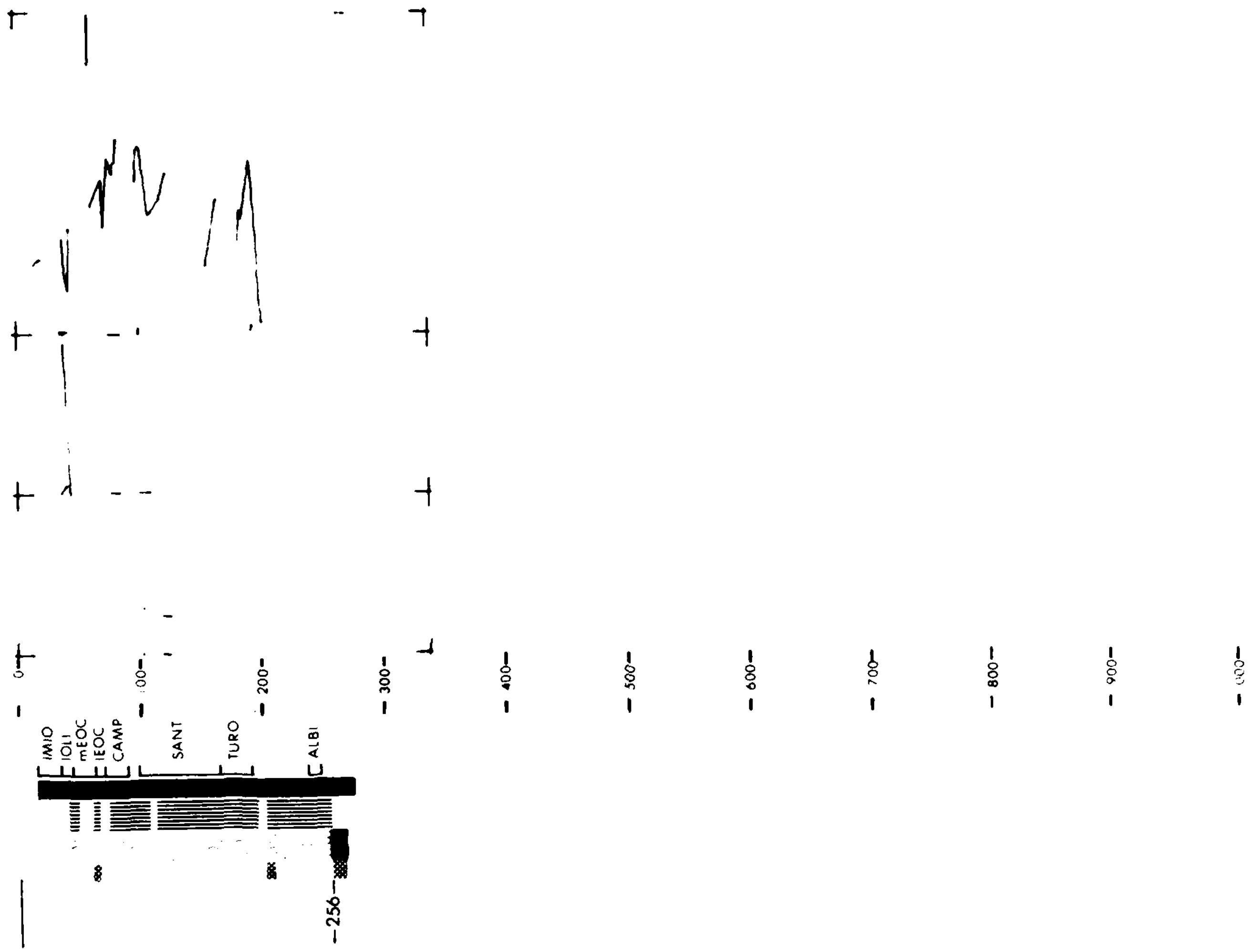
CORE DATA		
Penetration:		
Drilled----	0	meters
Cored----	260	meters
Total----	260	meters
Recovery:		
Basement-	2	cores
	8.9	meters
Total----	28	cores
	81	meters

Silica occurs throughout the column, both as Radiolaria and as chert, but it is most concentrated in middle and lower Eocene beds. The only calcareous materials cored are the few coccoliths in one core in the upper part of the Upper Cretaceous, and again in another core about 20 meters above the basement, in beds of Albian to Barremian age. Presumably, at all other times, the site was deeper than the compensation depth for calcium carbonate or was beneath a region of extremely low fertility. It is tempting to associate the upper occurrence of coccoliths with equatorial conditions, and the radiolarian-rich sediments of the Eocene with conditions along the north margin of the equatorial belt. The lower coccolith-bearing layers may indicate relatively shallow conditions near the rise crest, where the sea floor was above the calcium carbonate compensation depth. At Site 163, about 1300 km southeast of Site 164, highly calcareous sediments were cored in the Senonian, which rests there on basalt (Van Andel et al., 1971). The sea floor at Site 164, being older, may already have been in relatively deep water by Senonian times, but at least we have some evidence from Site 163 that by mid-late Cretaceous time the carbonate compensation depth lay deeper than the local rise crest.

One thin layer of siliceous sediment occurs in lower Oligocene time.



SITE 164 LEG 17



SITE DATA

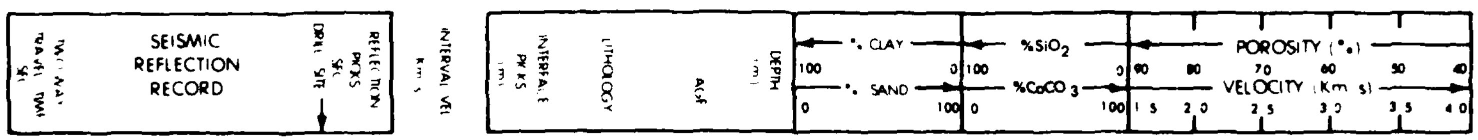
Position:
Latitude $8^\circ 10.7' N$
Longitude $164^\circ 51.6' W$
Date: 04/13/71
Time: 0320Z
Water depth: 5053 meters
Location: West of Line Island Chain

CORE DATA

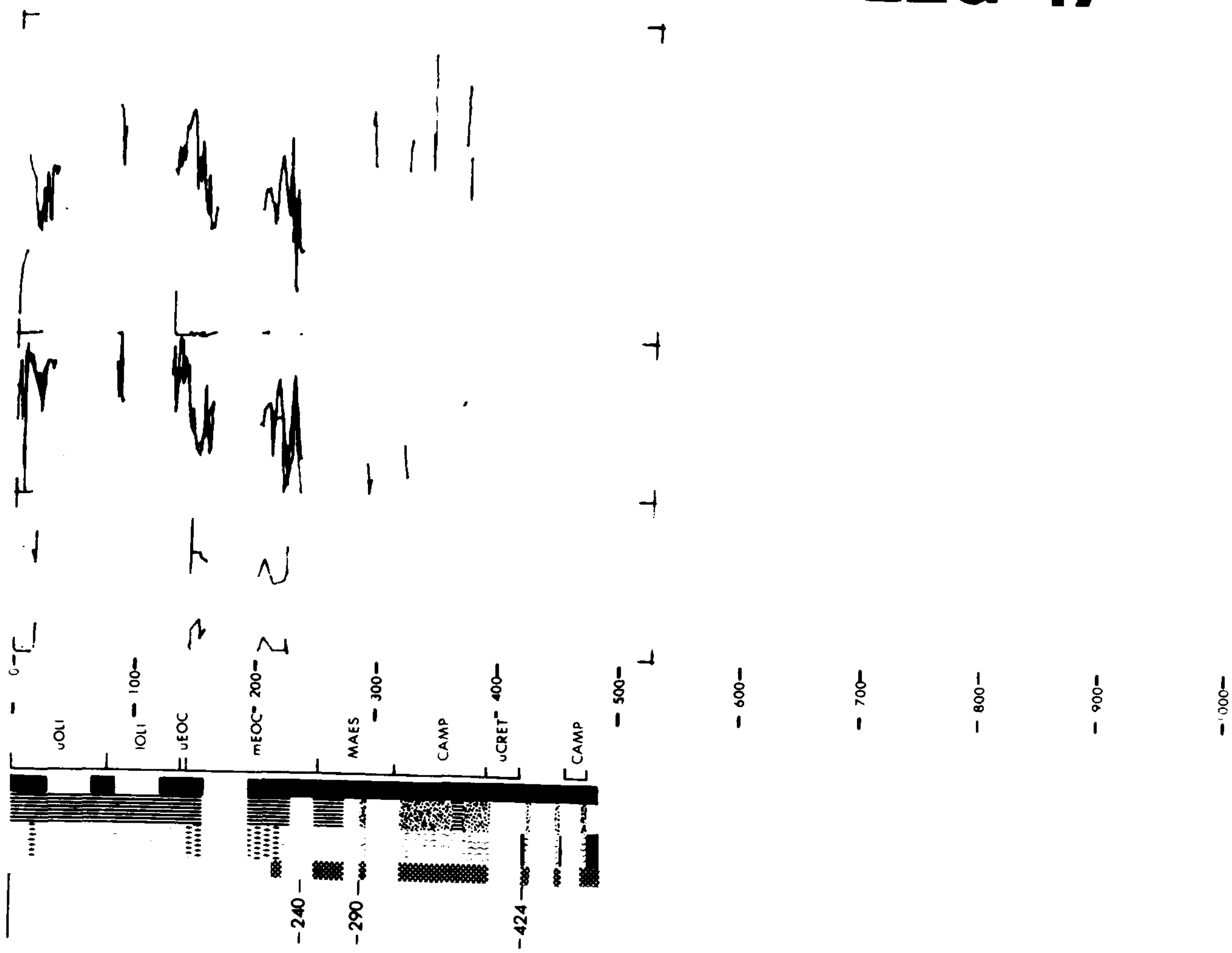
Penetration:	165	165A	
Drilled--	0	119	meters
Cored----	14	385	meters
Total----	14	504	meters
Recovery:			
Basement-	0	4	cores
	0	8.5	meters
Total----	2	29	cores
	7.5	139	meters

The source of the turbidites in Unit 2A is in a southeasterly direction, toward Kingman Reef and Palmyra Island. The alternation of calcareous turbidites and pelagic radiolarian ooze in Unit 2A suggests that the site was below the compensation depth during the Oligocene and early Miocene. Unit 2B, below the prominent seismic reflector, is lithologically not much different from the overlying beds except for the very thick turbidites at the top of the unit and for the lack of calcareous foraminifers in the turbidites. Within Unit 3, limestone turbidites attest to the presence of a Maastrichtian reef in the Line Island chain. A volcanogenic turbidite unit (Unit 4) contains minor marls and micritic limestones, which may be partly of turbidite origin and partly of pelagic origin. All the coarse clastic material is of volcanic origin; suggesting a relatively shallow-water origin. The chert and limestone unit was very sparsely sampled, and the fact that no Paleocene beds are represented may be due either to an unconformity or to gaps in the coring. The interbedded basalt and turbidites probably represent the final stages in the building of the local seamounts, some of which reached into fairly shallow water.

Interbedded siliceous, occasionally radiolaria rich, and calcareous, mostly nannofossil or foraminifera rich, sediments.



SITE 165 LEG 17



SITE DATA

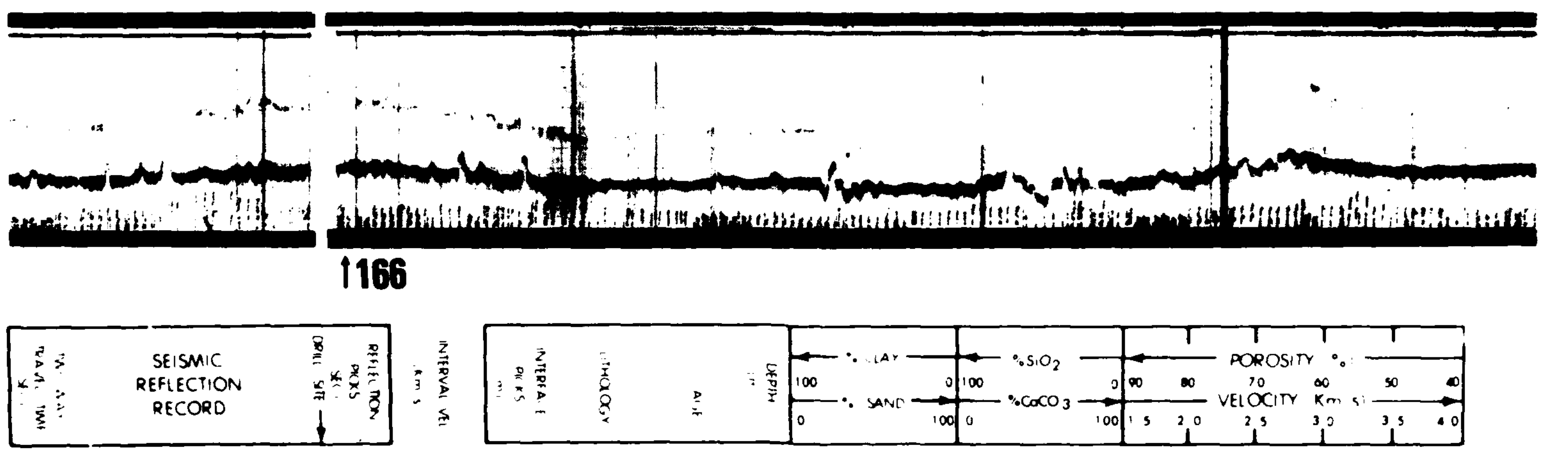
Position:
Latitude $3^{\circ}45.7'$ N
Longitude $175^{\circ}04.8'$ W
Date: 04/19/71
Time: 0745Z
Water depth: 4962 meters
Location: Central Pacific Basin

CORE DATA

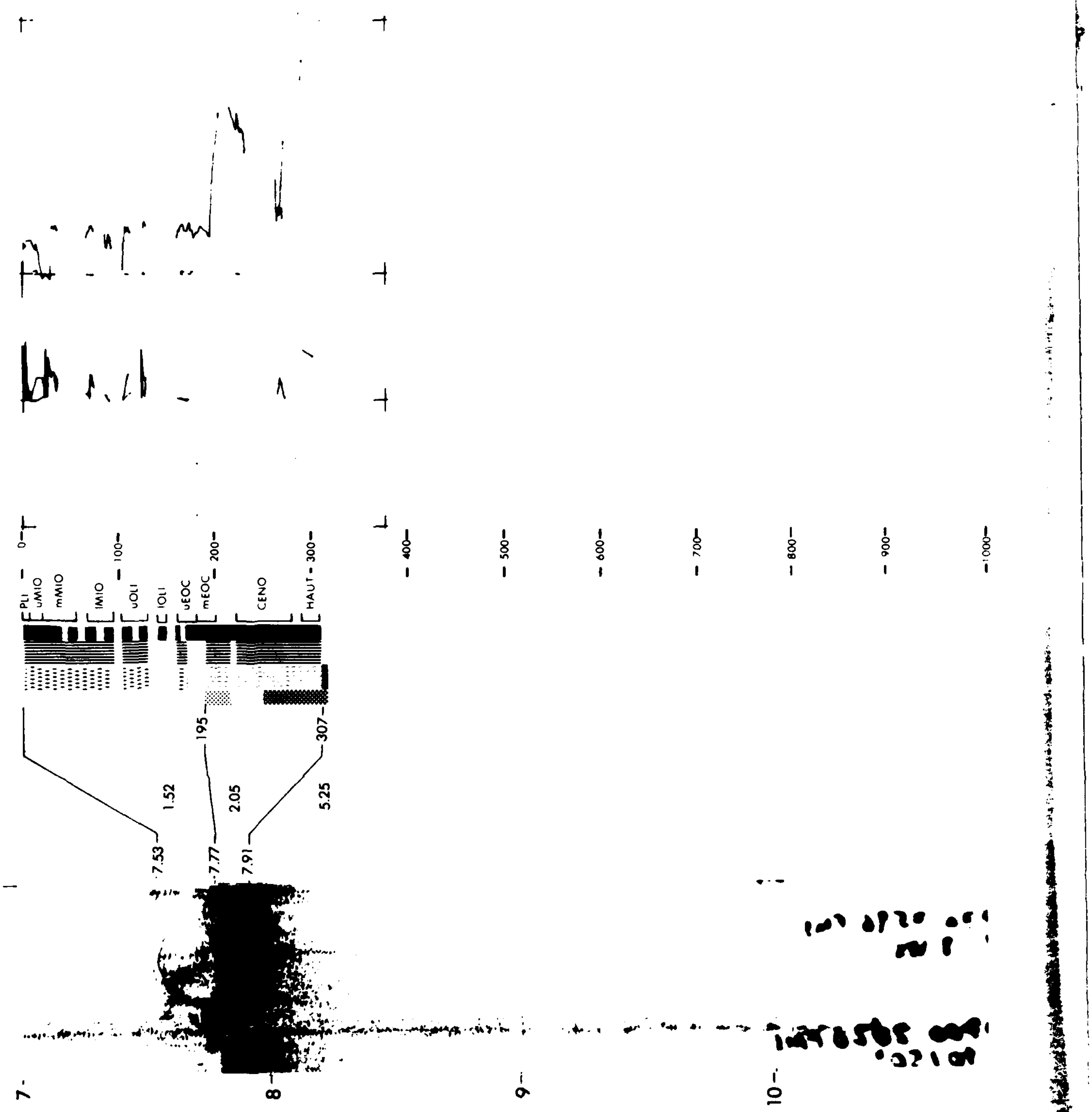
Penetration:
Drilled-- 73 meters
Cored---- 237 meters
Total---- 310 meters
Recovery:
Basement- 1 cores
3.5 meters
Total---- 29 cores
155 meters

The sea floor at this site is sediment of partly dissolved foraminifers, delicate radiolarian spines, and has a greater percentage of nannofossils than the underlying lower Pliocene radiolarian ooze. The difference may reflect some late Cenozoic change in the lysocline, or possible solution may continue in the upper part of the sediment column, in addition to solution of particles falling through the overlying water. The top of the chert cored at 195.2 meters must represent the top of the Opaque Layer at this site. Between 250 and either 271 or 279 meters the rock is of volcanic origin. It most likely is altered ash. However, it may be altered hyaloclastite moved a shorter distance by slumping and currents to this site, or some combination of pyroclastic and reworked hyaloclastic glass. The other principal rock type is breccia of lighter brown porcellanite that has been cemented by veinlets of limpid, drusy quartz. This chert apparently is the seismic reflector above the basement reflector at Site 166. Black selvages of brittle glass, partly altered to green montmorillonite, are evidence that the basalt was extrusive rather than emplaced as a sill.

Sediments occasionally nannofossil rich. One thin bed; calcareous, occurs in Hauterivian time.



SITE 166 LEG 17



SITE DATA

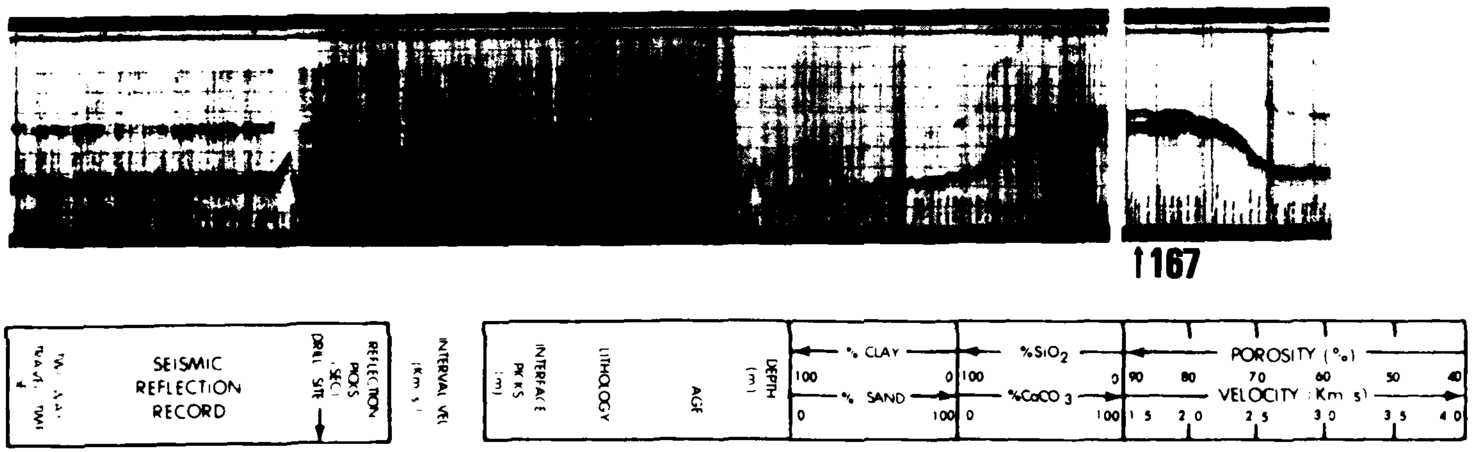
Position:
Latitude 7°04.1′ N
Longitude 176°49.5′ W
Date: 04/23/71
Time: 2242Z
Water depth: 3176 meters
Location: Magellan Rise

CORE DATA

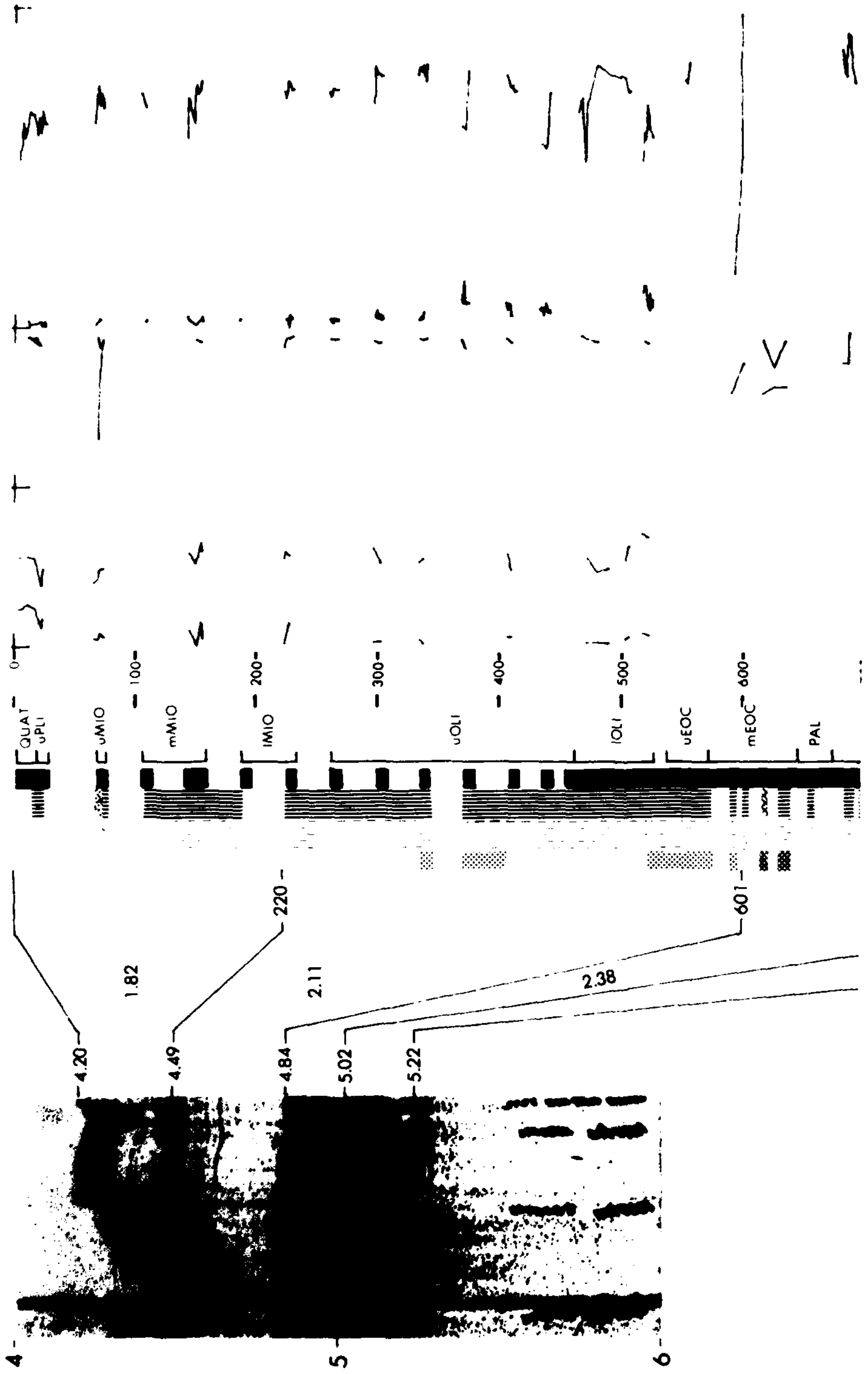
Penetration:
Drilled-- 318 meters
Cored---- 867 meters
Total----1185 meters
Recovery:
Basement- 2 cores
5.5 meters
Total---- 95 cores
299 meters

The sedimentary cover on Magellan Rise, which is nearly 1200 meters thick, consists almost entirely of biogenous calcium carbonate, ranging in age from earliest Cretaceous or latest Jurassic at the base to Quaternary at the top. The oldest sediments rest with depositional contact on altered and brecciated basalt. Two angular unconformities are visible in the sedimentary section, corresponding to the boundaries between Units 1 and 2 and between 2 and 3. The unconformity may record a change from sluggish bottom currents or less effective dissolution during the time of rapid accumulation in the Oligocene to more rapid currents or more dissolution in the late Tertiary. The other unconformity is evident near the position of the first cherts in the column (at a depth of 600 m). At the present time the sea floor at Site 167 is above the compensation depth for calcium carbonate, and the evidence obtained from the presence of calcareous nannofossils at all levels in the stratigraphic section indicates that this has been so ever since the beginning of Cretaceous times.

Sediments occasionally nannofossil rich. Two thin beds of siliceous sediment occur in lower Cretaceous time.



SITE 167



QUAT
uPLI
uMIO
mMIO
lMIO
uOLI
lOLI
uEOC
mEOC
PAL
0
100
200
300
400
500
600
220
601
1.82
2.11
2.38
4.20
4.49
4.84
5.02
5.22
4
5
6

SITE DATA

Position:
Latitude 10° 42.2' N
Longitude 173° 35.9' E
Date: 05/19/71
Time: 1923Z
Water depth: 5430 meters
Location: Central Pacific Basin

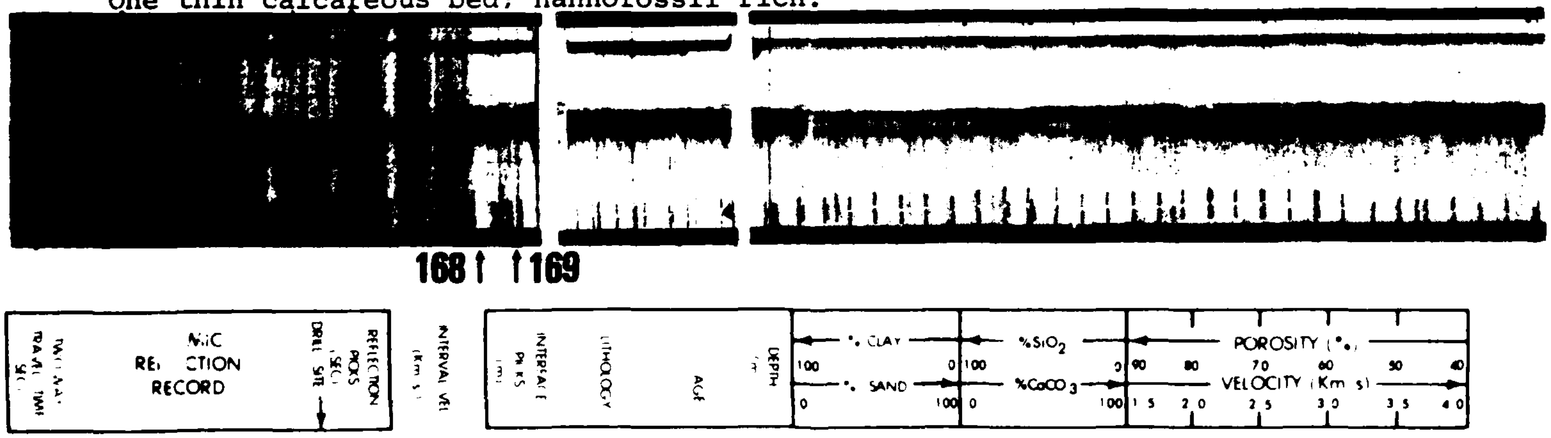
CORE DATA

Penetration:	
Drilled--	47 meters
Cored----	28 meters
Total----	75 meters
Recovery:	
Basement-	0 cores
	0 meters
Total----	5 cores
	7.5 meters

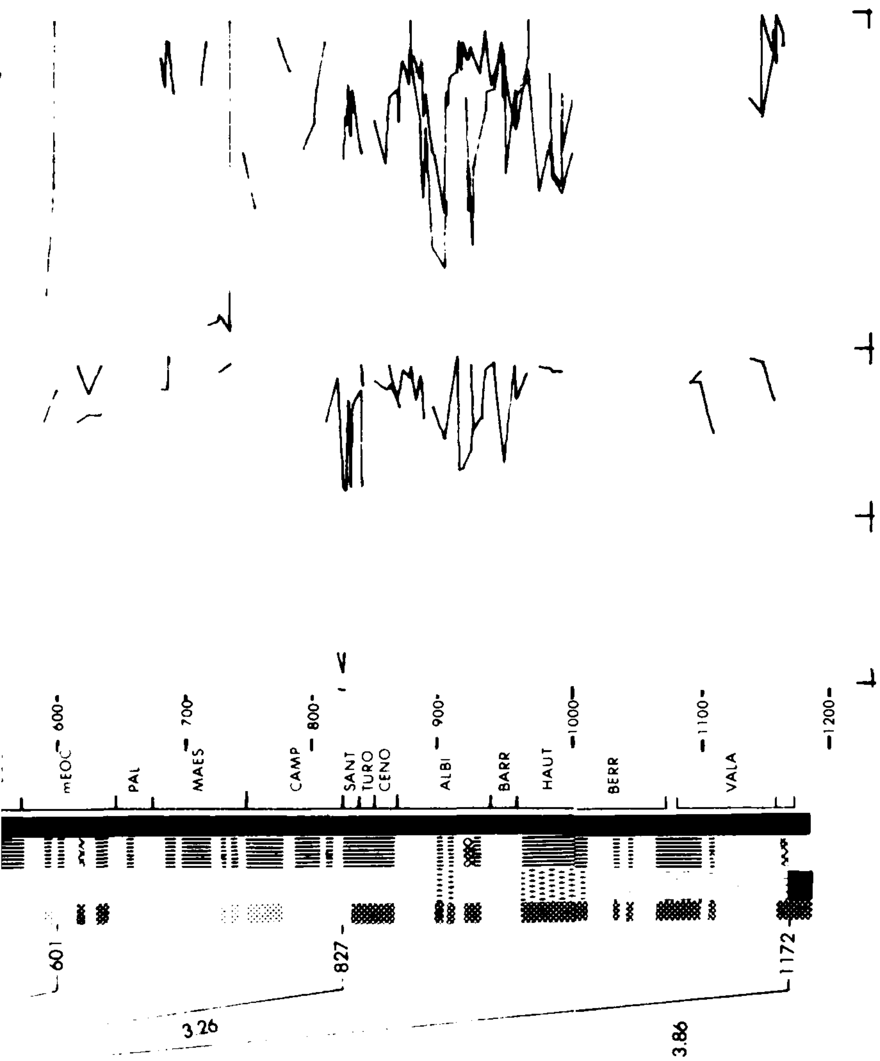
The results from both Sites 168 and 169 are considered here

The topmost sample, possibly right at the sea floor, contains badly dissolved fragments of Quaternary foraminifera, along with grains of feldspar and barite, but the very next sample contains Radiolaria of early Miocene age. The reflection profile shows a very irregular thickness of the upper transparent unit, as if it had been partly eroded away in some places. From 103 meters the strata of nannofossil-bearing claystone and minor chalk is interrupted by a 8-meter thick diabase sill, underlain by at least 2 meters of volcanogenic siltstone and claystone. The presence of nannofossil chalks in sediments 5600 meters deep suggests either a late Cretaceous lowering of the compensation depth for calcium carbonate, or post-depositional subsidence of the sea floor. In view of the scarcity fossils at Site 164, at nearly the same depth and within 3 degrees of latitude of Site 169, it seems reasonable to invoke subsidence at Site 169. The extrusive basalt at the base of the sedimentary column at Site 169 is at least as old as late Albian. This age is very much younger than any age obtained from extrapolation westward of spreading rates deduced from magnetic anomaly patterns and drilling results farther to the east.

One thin calcareous bed; nannofossil rich.



LEG 17


600
700
800
900
1000
1100
1200
mEOC
PAL
MAES
CAMP
SANT
TURO
CENO
ALBI
BARR
HAUT
BERR
VALA
601
827
1172
3.26
3.86

SITE DATA

Position:
Latitude $10^\circ 42.2'$ N
Longitude $173^\circ 35.9'$ E
Date: 05/19/71
Time: 1923Z
Water depth: 5430 meters
Location: Central Pacific Basin

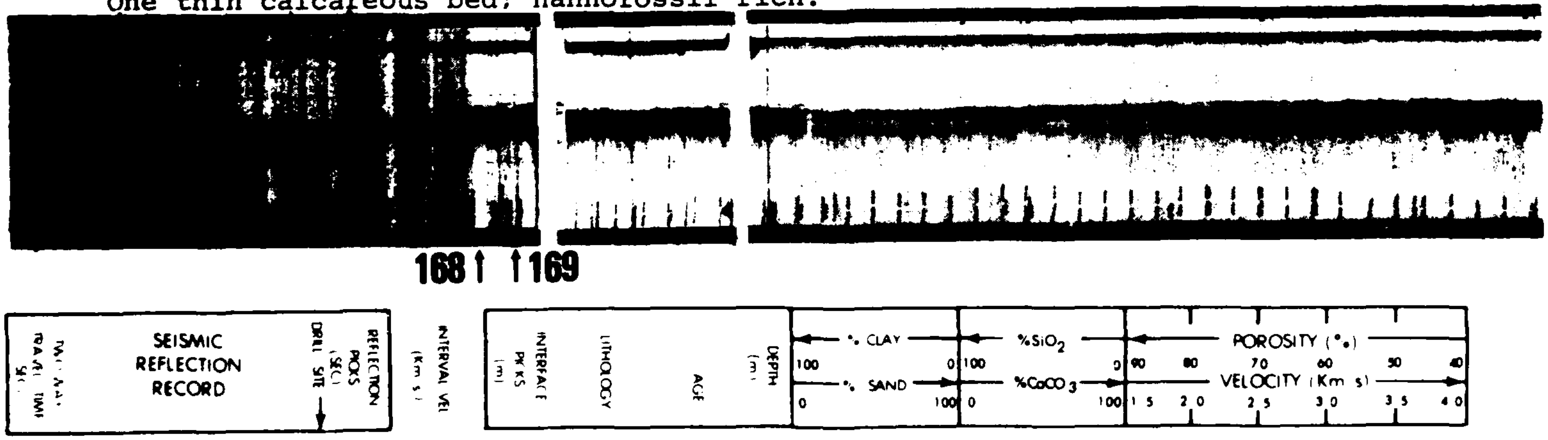
CORE DATA

Penetration:
Drilled-- 47 meters
Cored---- 28 meters
Total---- 75 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 5 cores
7.5 meters

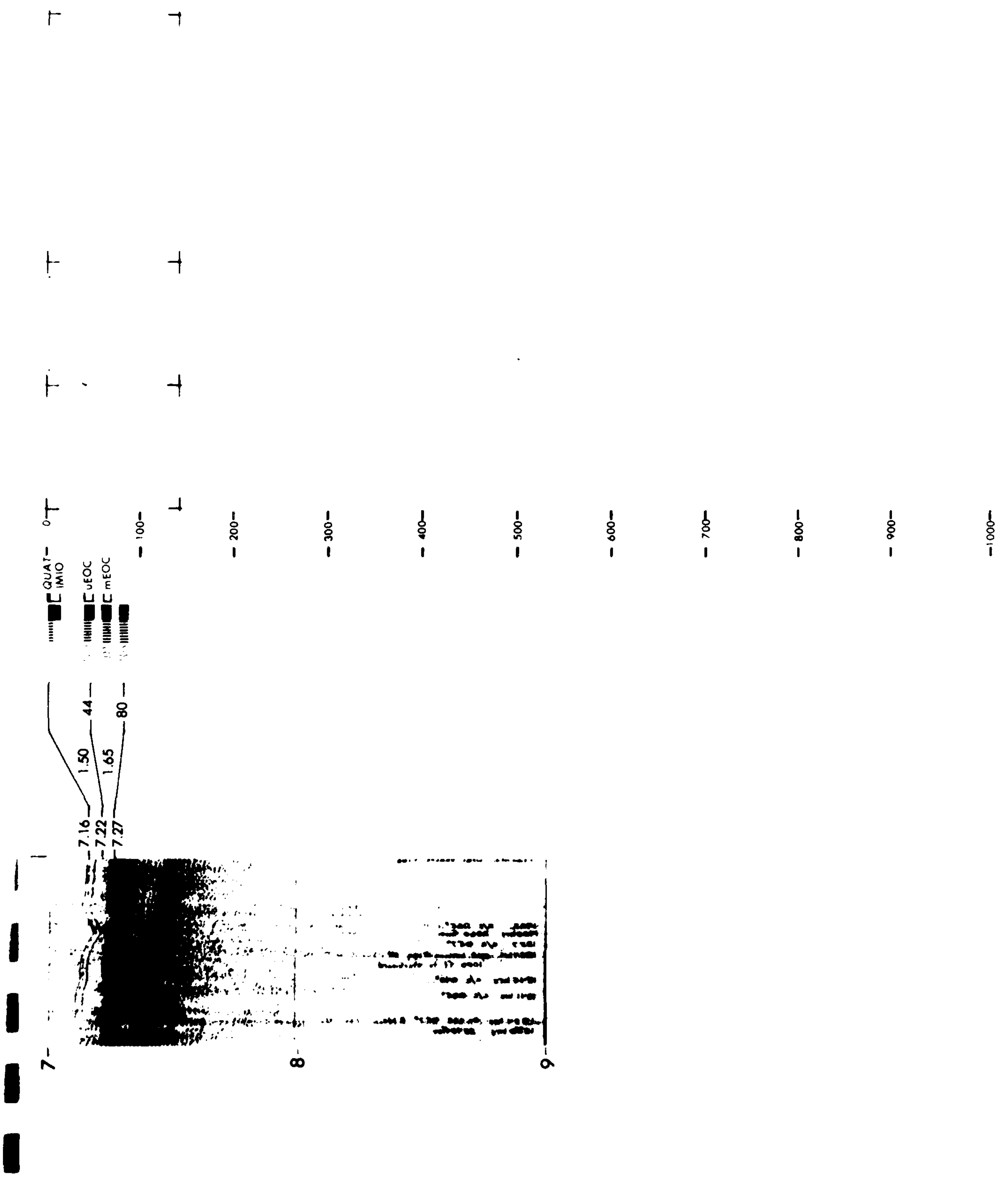
The results from both Sites 168 and 169 are considered here

The topmost sample, possibly right at the sea floor, contains badly dissolved fragments of Quaternary foraminifera, along with grains of feldspar and barite, but the very next sample contains Radiolaria of early Miocene age. The reflection profile shows a very irregular thickness of the upper transparent unit, as if it had been partly eroded away in some places. From 103 meters the strata of nannofossil-bearing claystone and minor chalk is interrupted by a 8-meter thick diabase sill, underlain by at least 2 meters of volcanogenic siltstone and claystone. The presence of nannofossil chalks in sediments 5600 meters deep suggests either a late Cretaceous lowering of the compensation depth for calcium carbonate, or post-depositional subsidence of the sea floor. In view of the scarcity fossils at Site 164, at nearly the same depth and within 3 degrees of latitude of Site 169, it seems reasonable to invoke subsidence at Site 169. The extrusive basalt at the base of the sedimentary column at Site 169 is at least as old as late Albian. This age is very much younger than any age obtained from extrapolation westward of spreading rates deduced from magnetic anomaly patterns and drilling results farther to the east.

One thin calcareous bed; nannofossil rich.



SITE 168 LEG 17



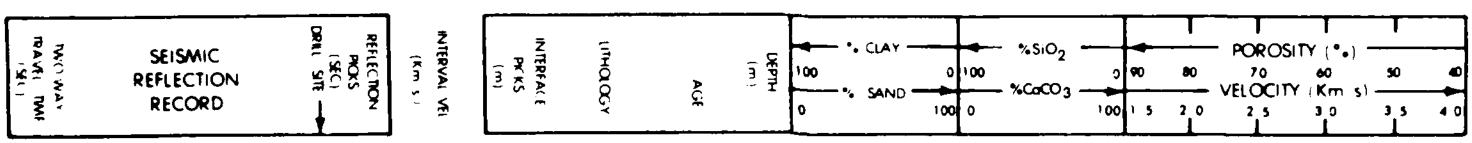
SITE DATA

Position:
Latitude 10°40.2' N
Longitude 173°33.0' E
Date: 05/10/71
Time: 1854Z
Water depth: 5415 meters
Location: Central Pacific Basin

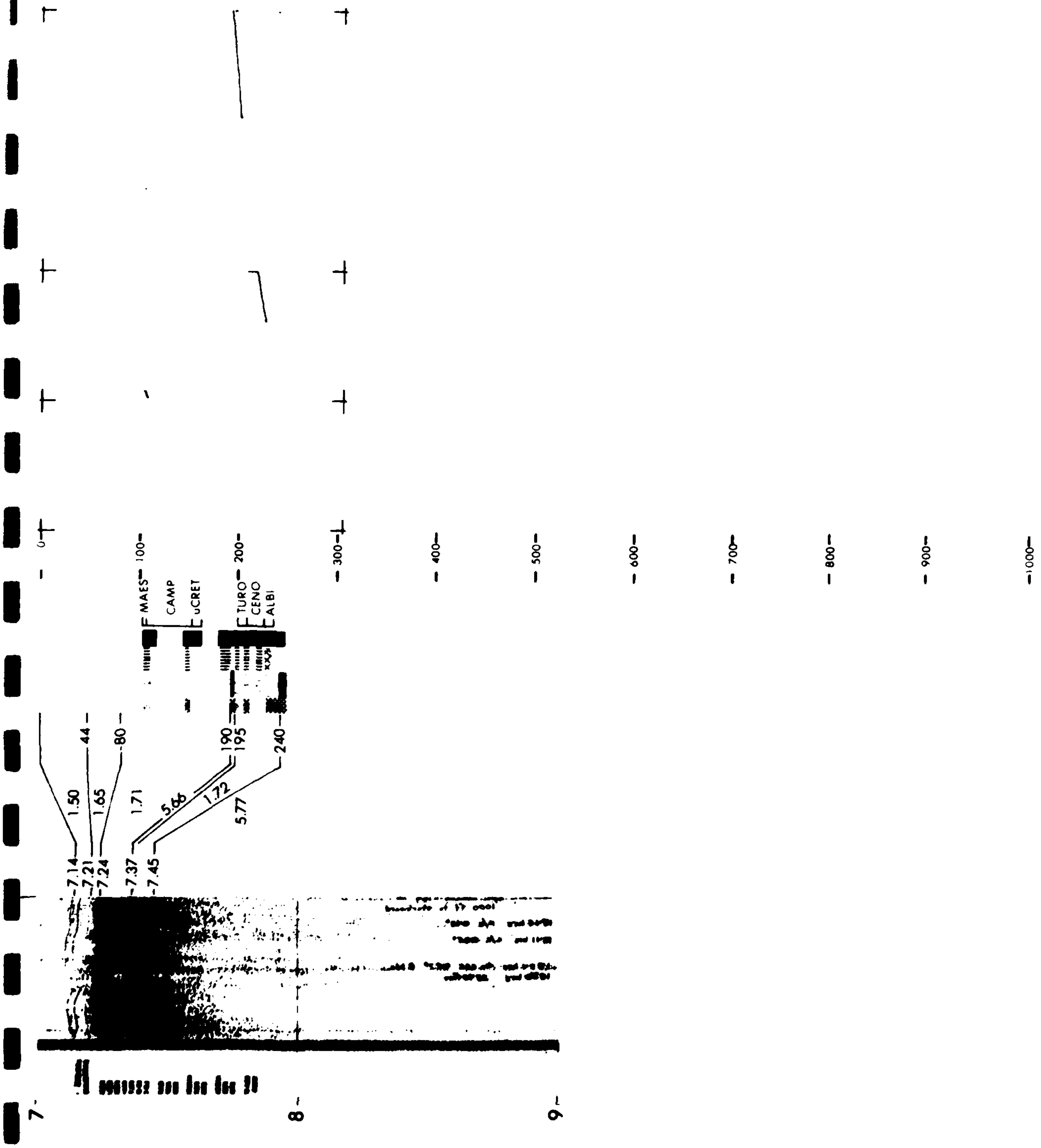
CORE DATA

Penetration:
Drilled-- 142 meters
Cored---- 96 meters
Total---- 238 meters
Recovery:
Basement- 2 cores
1 meters
Total---- 12 cores
12 meters

Discussion with Site 168.



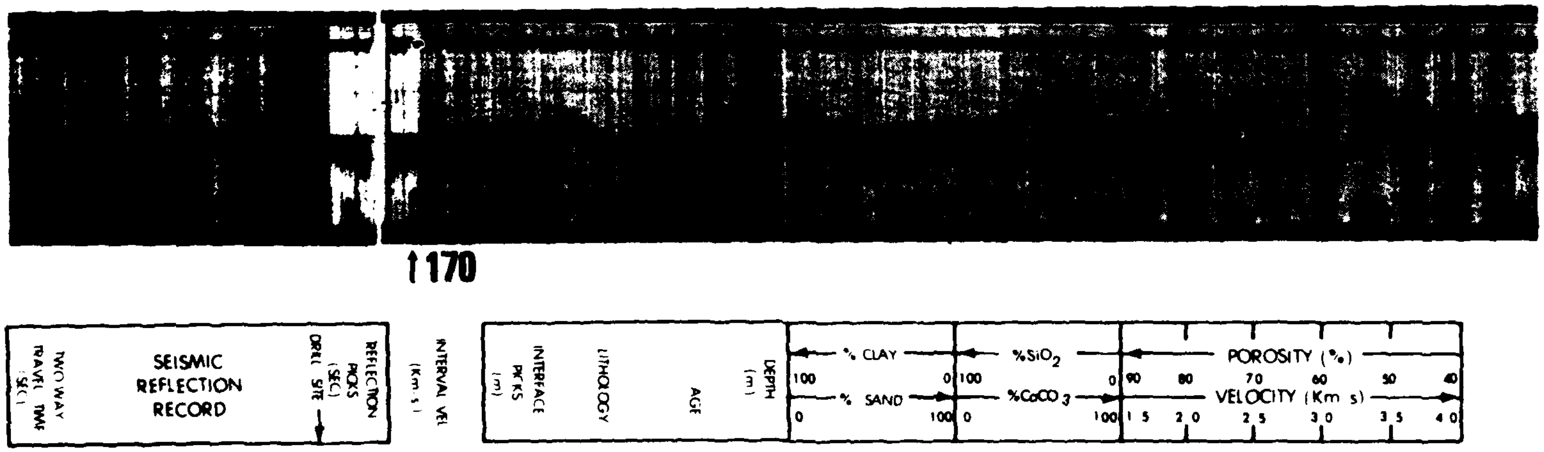
SITE 169 LEG 17



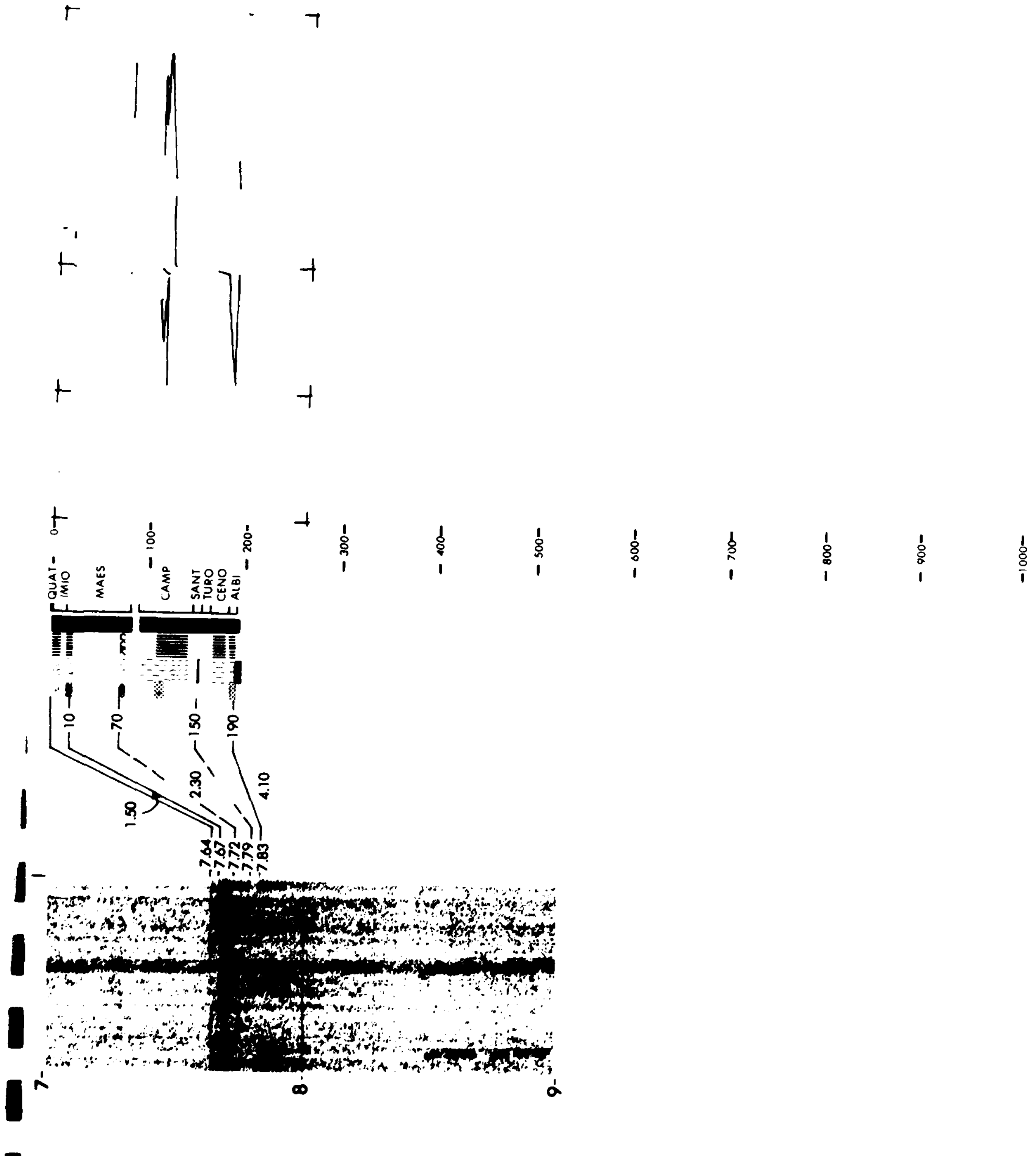
SITE DATA		CORE DATA	
Position:		Penetration:	
Latitude	11°48.0' N	Drilled--	62 meters
Longitude	177°37.0' E	Cored----	134 meters
Date:	05/12/71	Total----	196 meters
Time:	0128Z	Recovery:	
Water depth:	5792 meters	Basement-	1 cores
Location:	Northwest Central Pacific Basin		3 meters
		Total----	16 cores
			31 meters

The occurrence of carbonate-rich sediments at such a great depth (5800 m) poses the problem of the relative rates of subsidence and changing calcium carbonate compensation depths. Evidence of size sorting and reworking of older foraminifera in Campanian strata suggest that at least some of the calcareous material may be displaced from shallower sites, and this is supported by color and size-graded beds in the same part of the section. Over most of the upper Cretaceous, the amount of material recovered in the cores is too small to see much in the way of sedimentary structures that might indicate the presence of turbidite layers. The occurrences of foraminifera and nannofossils suggest that the sea floor at Site 170 lay at or just below the compensation depth for calcium carbonate during the early Campanian, but was shallower than this depth at other times during the late Cretaceous and Albian. Whether the site was ever above the lysocline for planktonic foraminifera is moot in view of the possibility of displaced faunas. Nonetheless, the abundance of foraminifera in the Maestrichtian suggests that the sea floor may have been above the lysocline at that time.

One thin bed in lower Miocene time. Other sediment occasionally nannofossil rich.



SITE 170 LEG 17



SITE DATA

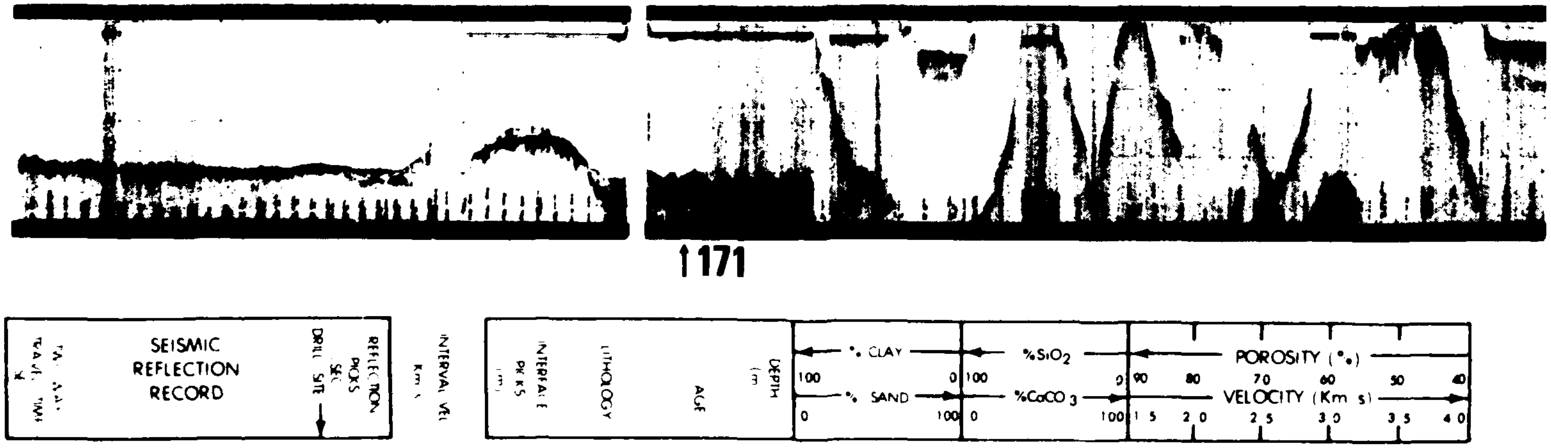
Position:
Latitude 19°07.9' N
Longitude 169°27.6' W
Date: 05/19/71
Time: 1230z
Water depth: 2295 meters
Location: Horizon Guyot

CORE DATA

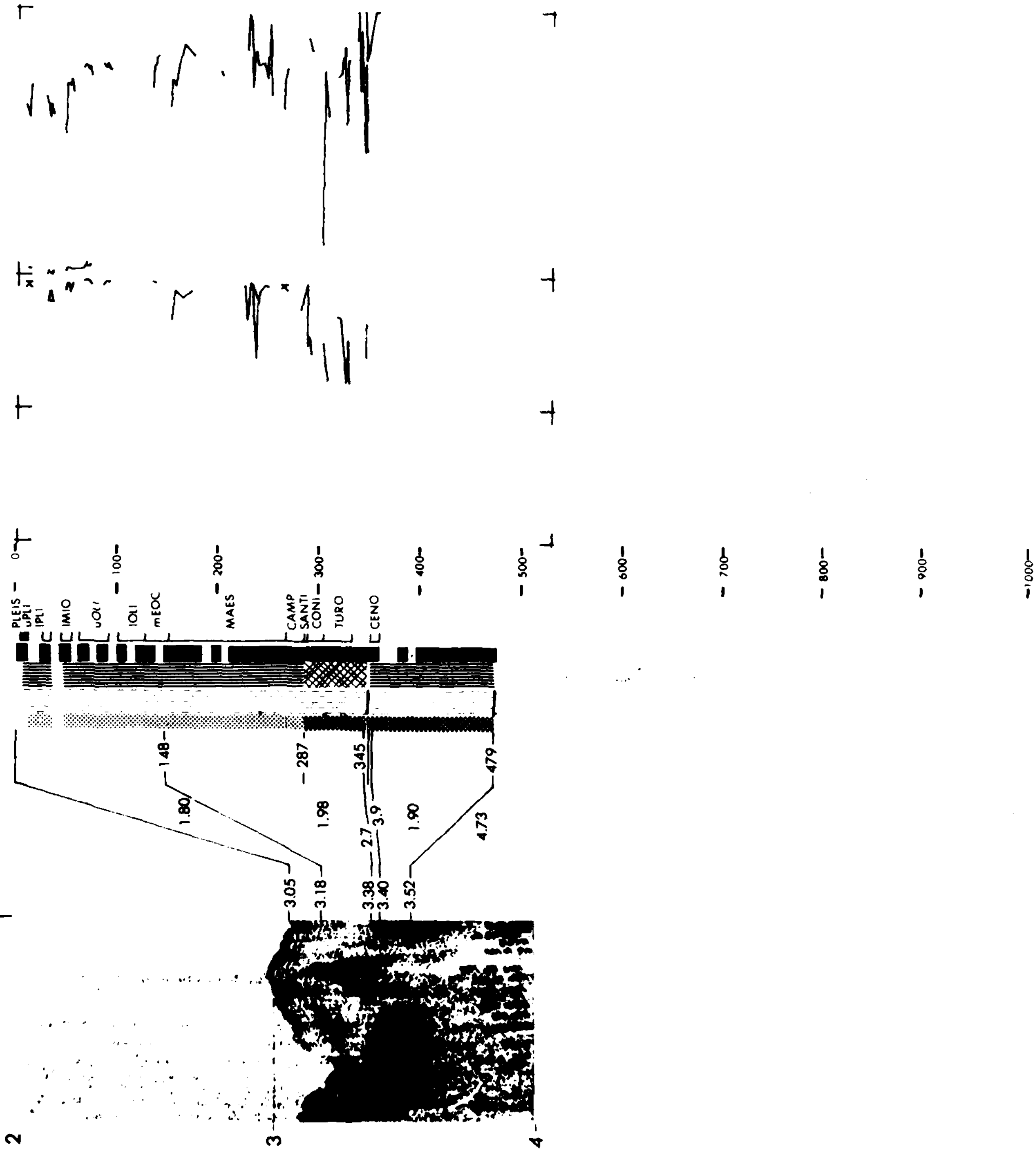
Penetration:
Drilled-- 118 meters
Cored---- 356 meters
Total---- 474 meters
Recovery:
Basement- 1 cores
.03 meters
Total---- 33 cores
173 meters

The most striking feature of the column is the evidence for shallow water, and perhaps even nonmarine environments at close hand to the drilled site. The evidence consists of the shallow-water types of molluscs and aggultinated foraminifera in the upper part of Unit 4, in the Cenomanian; the woody plant fragments in the volcanic sandstones in the Turonian and Coniacian; and, in the limestone-basalt conglomerate, the highly vesicular and weathered basalt fragments that resemble subaerial flow rocks. The difference in depth between the top of the guyot and the beds with shallow-water or terrestrial materials is now about 1100 meters. Very close to the site, the basement rocks appear to crop out on the southern edge of the saddle region, about 2 km south of the site and shallow-water conditions may have prevailed there during deposition of sediments at Site 171. The coarse shallow-water debris accumulated more rapidly than the average rate in the overlying deeper water glauconitic and volcanogenic section, which may well contain an unconformity near the top. Another notable feature of the geologic history at Site 171 is the recurrence of volcanism, at least 5 m.y. and perhaps as much as 30 m.y. after the eruption of the older basalt.

Sediments rarely nannofossil and once foraminifera rich.



SITE 171 LEG 17



SITE DATA

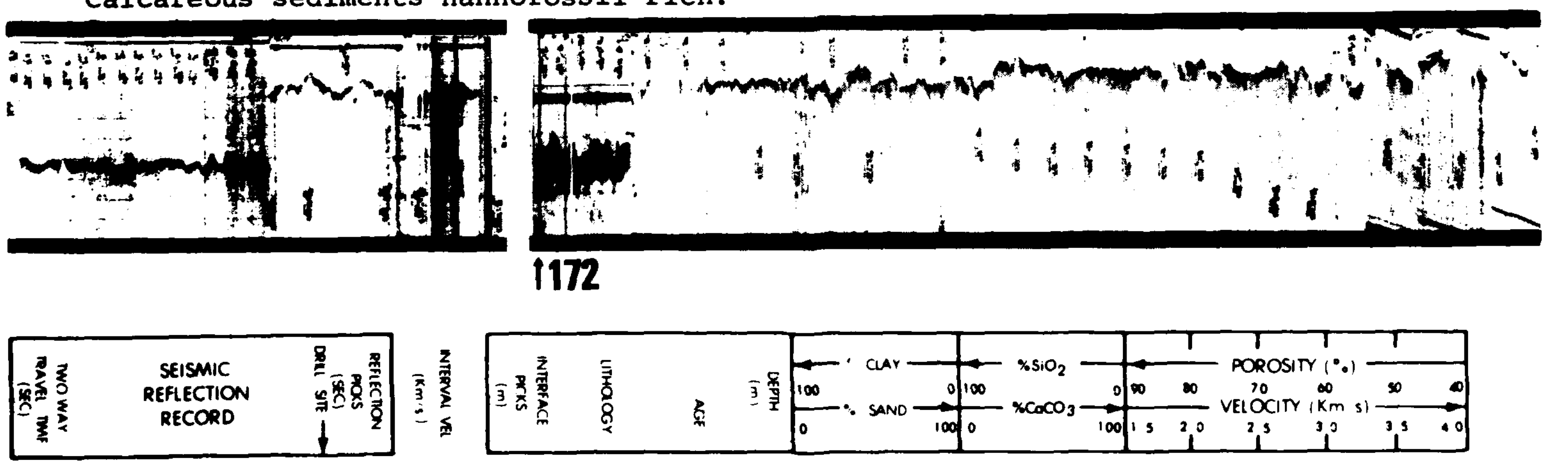
Position:
  Latitude 31° 32.2' N
  Longitude 133° 22.4' W
Date: 06/04/71
Time: 0400Z
Water depth: 4768 meters
Location: South of the Murray Fracture Zone

CORE DATA

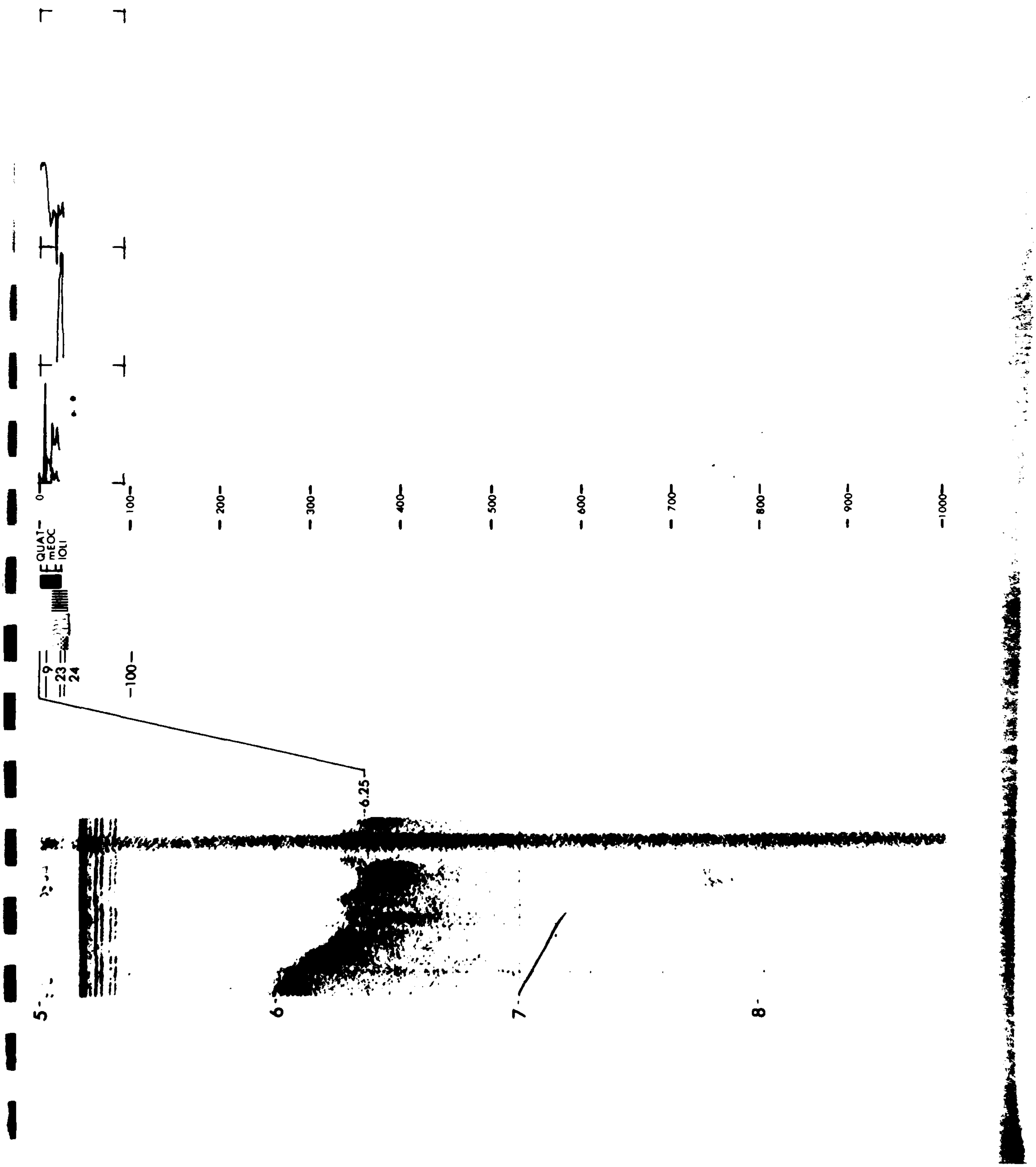
Penetration:	172	172A	
Drilled--	0	24	meters
Cored----	24	0	meters
Total----	24	24	meters
Recovery:			
Basement-	1	1	cores
	.03	.03	meters
Total----	4	1	cores
	26	.03	meters

The sedimentary section consists predominately of pelagic moderate brown clay in the upper 9 meters which changes to a zeolite-rich brown clay, brown clay zeolitite and zeolitite in the lower 9 to 23 meters. A horizon of pale orange nannofossil oozes occurs in the lower part of the latter interval in close proximity to basalt. Although the sediments above the ooze are essentially barren of conventional microfossils, fish teeth indicate a rather complete Miocene section. Glassy to finely crystalline basalt fragments were recovered in the two holes drilled at Site 172. Chemical analysis of the oxide content indicates tholeiitic basalt with a composition between tholeiitic basalts from spreading ridges and tholeiitic basalt from seamounts and oceanic islands. The volcanic material recovered at Site 172 most likely originated through rapid quenching in sea water of either a tuff-breccia or pillow flow. The thin lens of Early Oligocene calcareous oozes found at Site 172 may be the northern extension of Early Oligocene to Early Miocene carbonate associated with the eastern equatorial belt of high productivity. If this is correct, it may be further evidence for a depressed calcium carbonate compensation level below 5000 meters.

Calcareous sediments nannofossil rich.



SITE 172 LEG 18



SITE DATA

Position:
Latitude 39°57.7' N
Longitude 125°27.1' W
Date: 06/13/71
Time: 0820Z
Water depth: 2927 meters
Location: Northern California continental slope

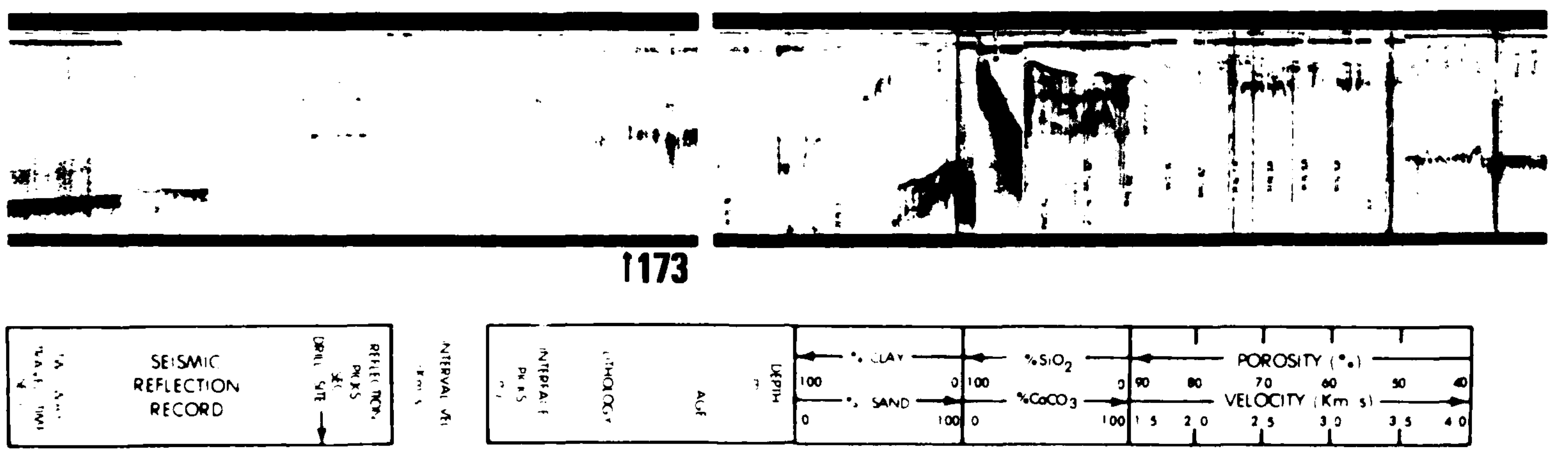
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 334 meters
Total---- 334 meters
Recovery:
Basement- 3 cores
.5 meters
Total---- 38 cores
196 meters

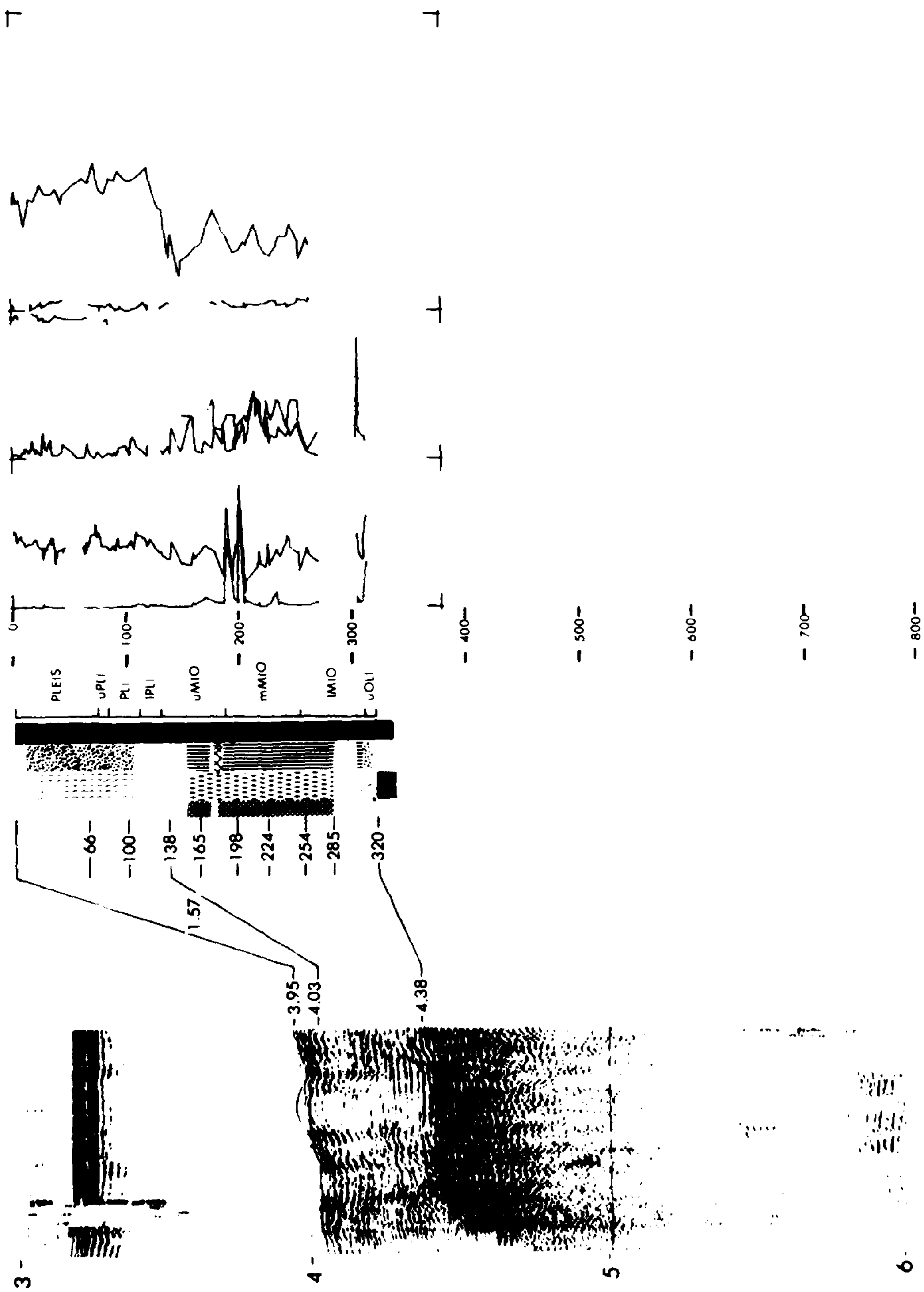
The Franciscan Formation may form a basement in this area.

Above the possible Franciscan is an andesite. Since the occurrence of andesite is rare in deep water, this unit may have been extruded and altered in shallow water. The basement complex was broken by large steep faults no later than late Oligocene or early Miocene time. This deformation may correlate with an episode of major tectonism that began along the adjacent California coast in late Oligocene or early Miocene time. Subsequent layered units are not deformed and no local tectonism is apparent in the area after this event but later regional deformation is possible. Terrigenous sedimentation was low from late Oligocene (?) through most of the Miocene. During this time nannofossil ooze and then diatomaceous sediments accumulated at a relatively slow rate. The environments deduced from lithologic and paleontologic data indicate continental slope conditions prevailed at this site throughout the Miocene. At the end of Miocene time, an influx of terrigenous sediment dominated with rates of accumulation about twice previous rates. This influx may have been a function of a progressive seaward prograding of terrigenous sediments in addition to any climatic fluctuations.

Siliceous sediments diatom rich. One thin bed in lower Miocene time; calcareous, and nannofossil rich.



SITE 173 LEG 18



SITE DATA

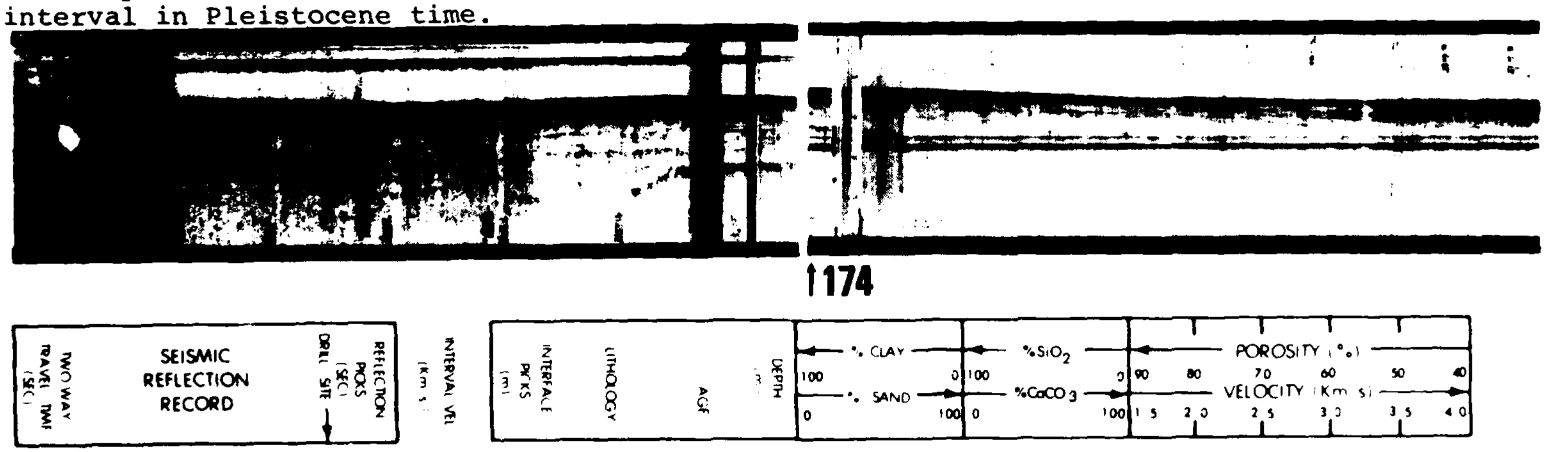
Position:
Latitude $44^{\circ}53.4'$ N
Longitude $126^{\circ}20.8'$ W
Date: 06/14/71
Time: 1624Z
Water depth: 2815 meters
Location: Astoria Fan

CORE DATA

Penetration:	174	174A	
Drilled--	0	474	meters
Cored----	19	404	meters
Total----	19	879	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	3	43	cores
	3	200	meters

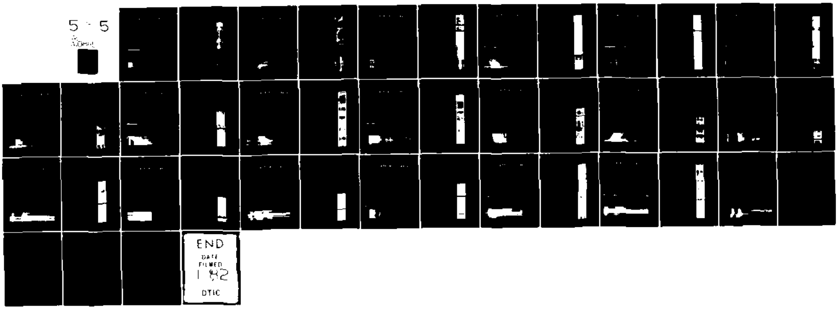
Some warm and cool climatic oscillations within the Pleistocene sequence can be identified. Although there is probably a correlation between climatic oscillations and changes in lithologies on Astoria Fan, the sedimentation processes associated with fan development, such as shifting fan channels, probably obscures it. The acoustic discontinuity noted on the seismic reflection records corresponds approximately to the break between the two major lithologic units. There is no indication, based upon the fauna, flora, and lithologies, that the discontinuity is an erosional surface or represents a major break in the depositional record. The medium to very fine sand turbidites of the upper stratigraphic unit represent the distal deposits of a prograding fan. Site 174 is located 275 km south of the Columbia River, the principal source of these sediments. Coarser grained deposits have been piston cored in the proximal environments near the mouth of Astoria Canyon which supplies sediment to the fan. In contrast, the finer grained deposits of the lower stratigraphic unit most likely represent abyssal plain sedimentation, similar to that found in the western part of Cascadia Basin during the late Pleistocene.

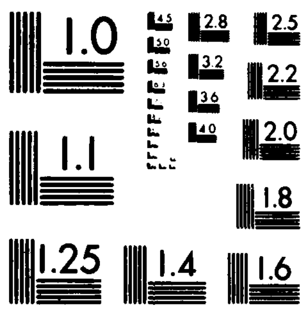
Top of the cored section; detrital, occasionally mica rich. One thin calcareous interval in Pleistocene time.



AD-A108 115 NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 8/10
A SUMMARY OF SELECTED DATA: DSDP LEGS 1-19.(U)
SEP 80 E C SNOW, J E MATTHEWS

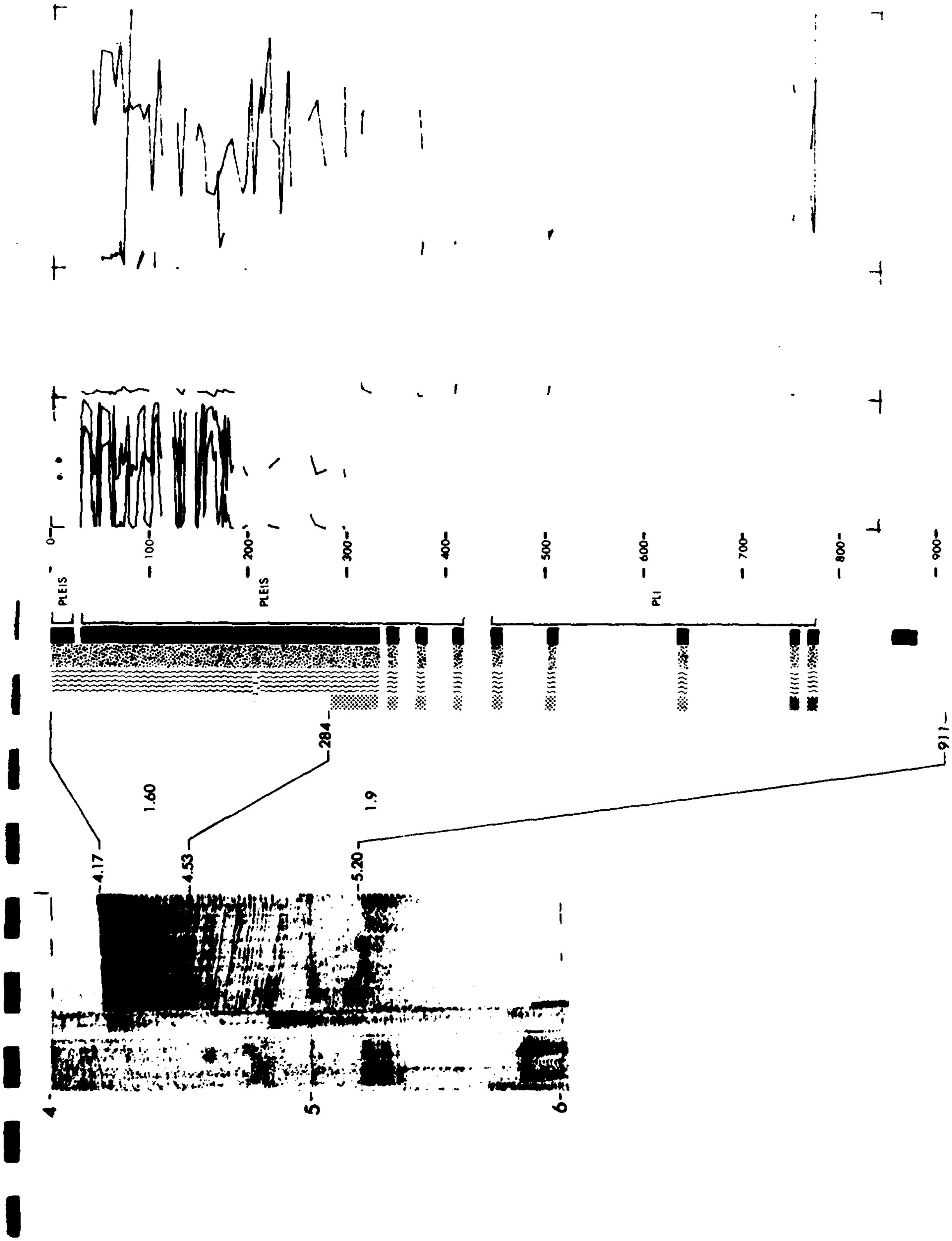
UNCLASSIFIED NORDA-25 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

SITE 174 LEG 18



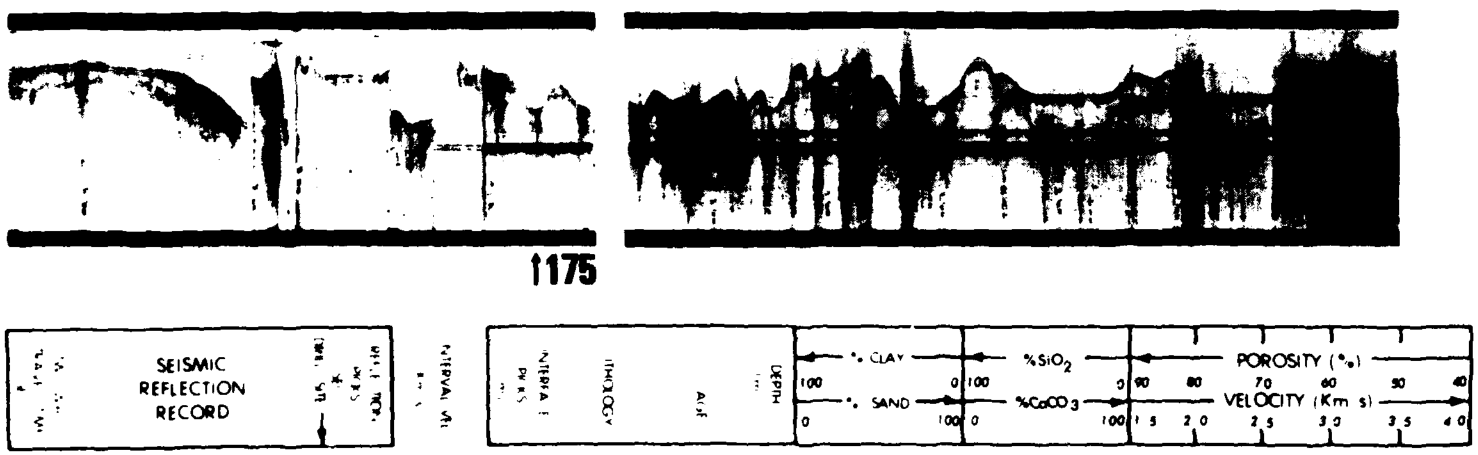
SITE DATA

Position:
Latitude 44°50.2' N
Longitude 125°14.5' W
Date: 06/21/71
Time: 0337Z
Water depth: 1999 meters
Location: Central Oregon continental slope

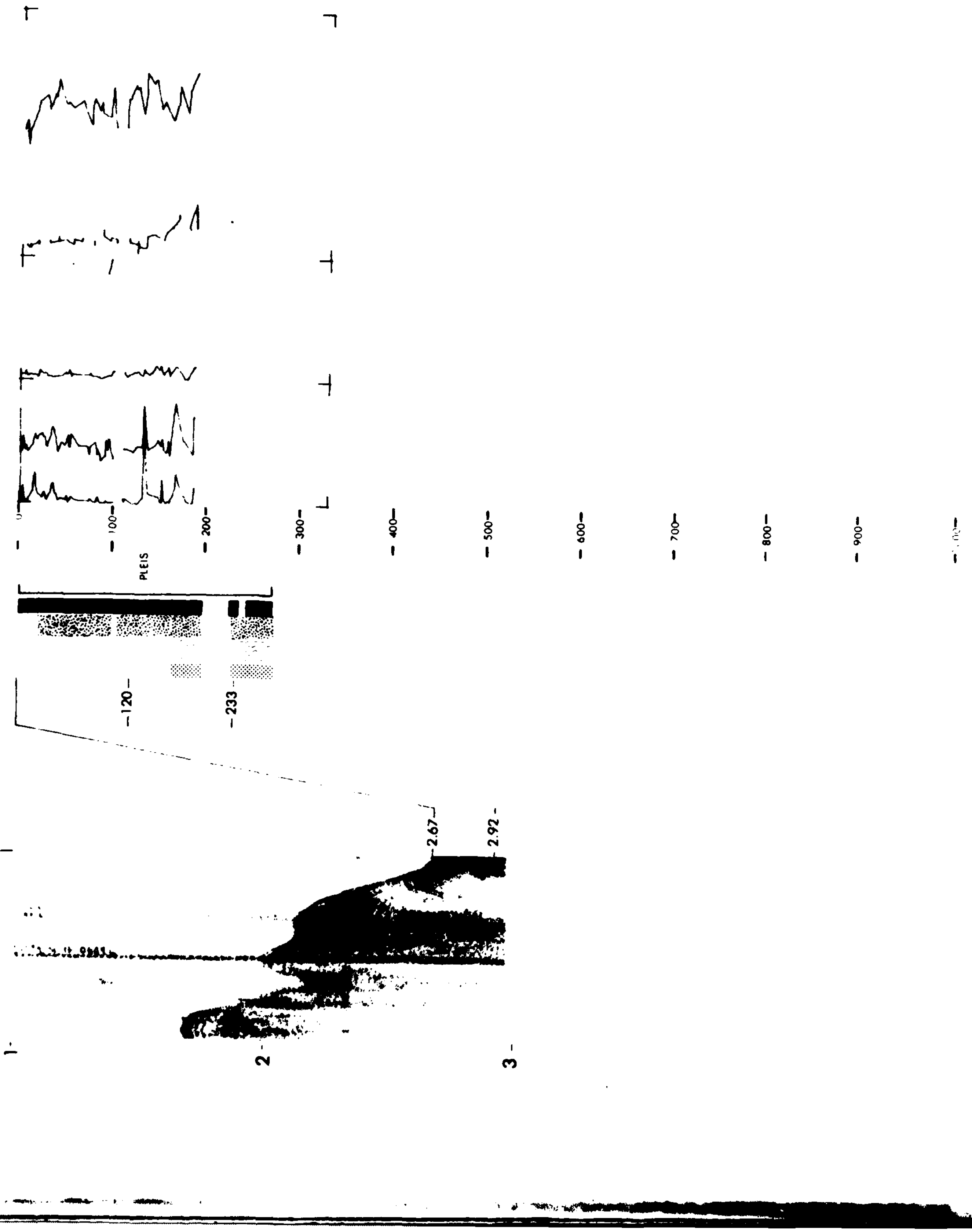
CORE DATA

Penetration:		
Drilled--	38	meters
Cored----	233	meters
Total----	271	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	25	cores
	122	meters

The benthonic foraminiferal assemblage in the interval between 0 to 72 meters is characteristic of lower middle bathyal environments or the present water depth of the site. The interval from 72 to 157 meters contains an excellent paleobathymetric index species which is common to lower bathyal environments. Uplift of abyssal plain deposits occurred between 0.3 and 0.45 m.y. B.P. During this short interval of time there was sufficient uplift to produce the significant change in water depth noted in the benthonic foraminiferal assemblages. A large anticlinal structure developed on the lower continental slope immediately adjacent to the flat-lying sediments of abyssal plain. This outermost structure is the youngest in a series of anticlinal and synclinal folds that form the continental slope. When the last and youngest fold formed, a sediment pond developed between the two anticlines. Turbidity current deposition declined as the site was elevated above the abyssal plain out of the reach of bottom transporting currents originating higher on the continental slope. The upper 20 meters of the sedimentary section consists of diatom-bearing silty clay and represents hemipelagic sedimentation.



SITE 175 LEG 18



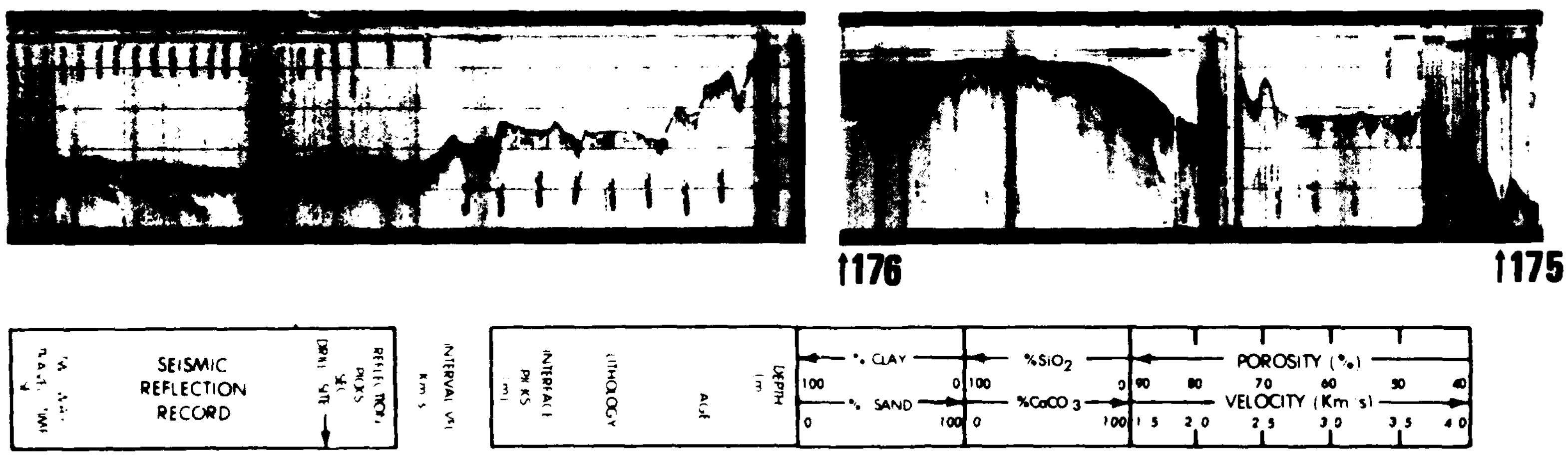
SITE DATA

Position:
Latitude 45°56.0' N
Longitude 124°37.0' W
Date: 06/22/71
Time: 0035Z
Water depth: 193 meters
Location: Northern Oregon continental shelf

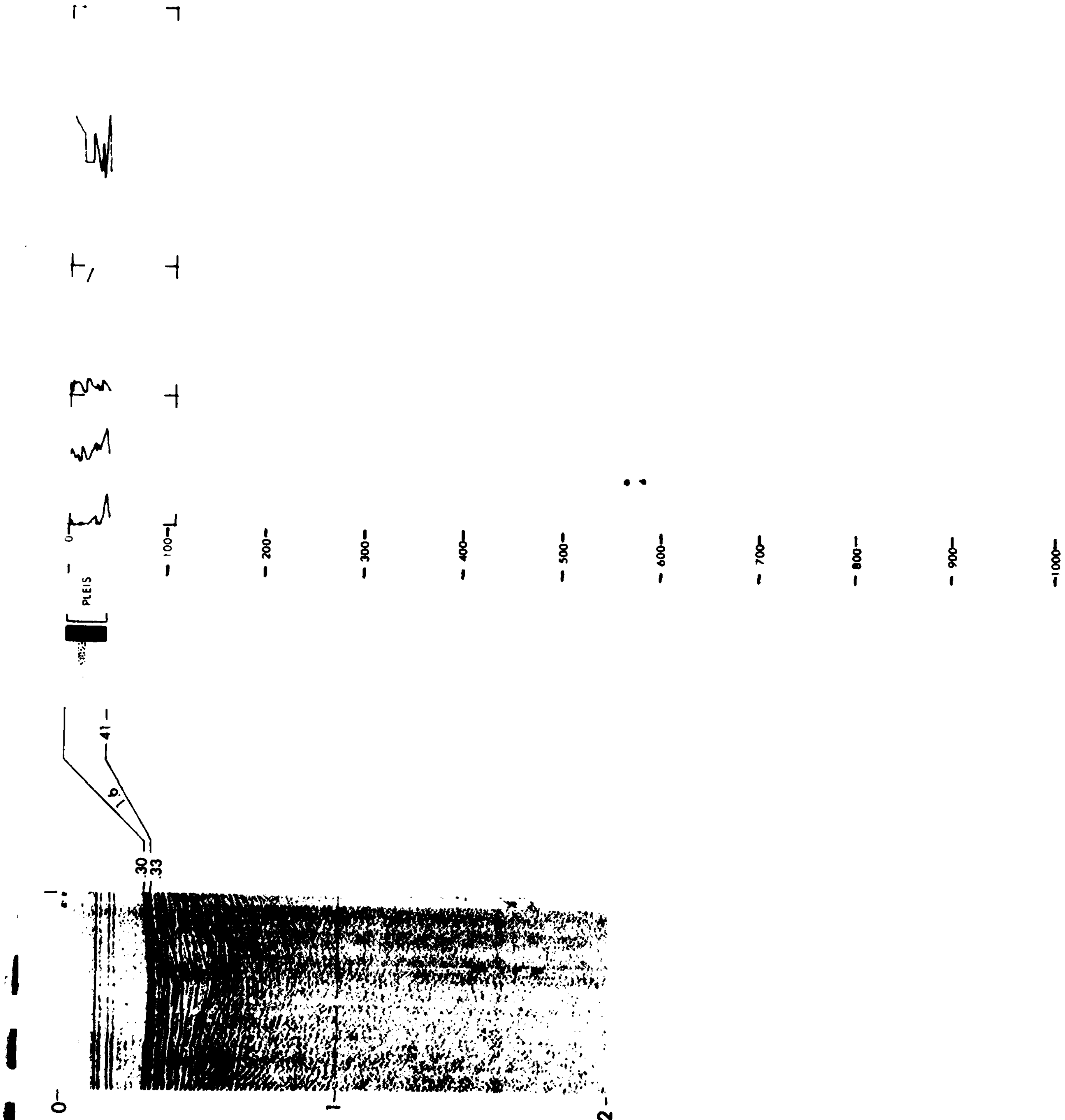
CORE DATA

Penetration:
Drilled-- 0 meters
Cored---- 41 meters
Total---- 41 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 5 cores
41 meters

The sedimentary section consists of two units separated by a Pliocene-Pleistocene angular unconformity. The upper unit (0-41m) consists of Pleistocene greenish gray clayey silt which contains detrital carbonate. Thin beds of glauconitic sand and a fine-grained conglometatic limestone layer also occur within this interval. The lower unit (41m) is a Pliocene olive gray fissile shale. It was recovered in the core catcher of Core 5. This shale unit contains a benthonic assemblage indicative of upper bathyal depths 500 meters or deeper. These paleo-depths imply uplift of the shale unit to shelf depths with subsequent truncation by erosion during a former low stand of the sea. This surface has since been covered by a thin blanket of Pleistocene shelf sediments represented by Unit 1. Assuming that the unconformity was produced by wave action in the nearshore region as the data suggest, this erosional surface presently lies at a depth of 234 meters below sea level at the drill site and much deeper than the late Wisconsin lowering of sea levelof approximately 125 meters. The unconformity also dips seaward. The outer edge of the shelf must have begun to subside as the blanket of Pleistocene sediments was deposited.



SITE 176 LEG 18



SITE DATA

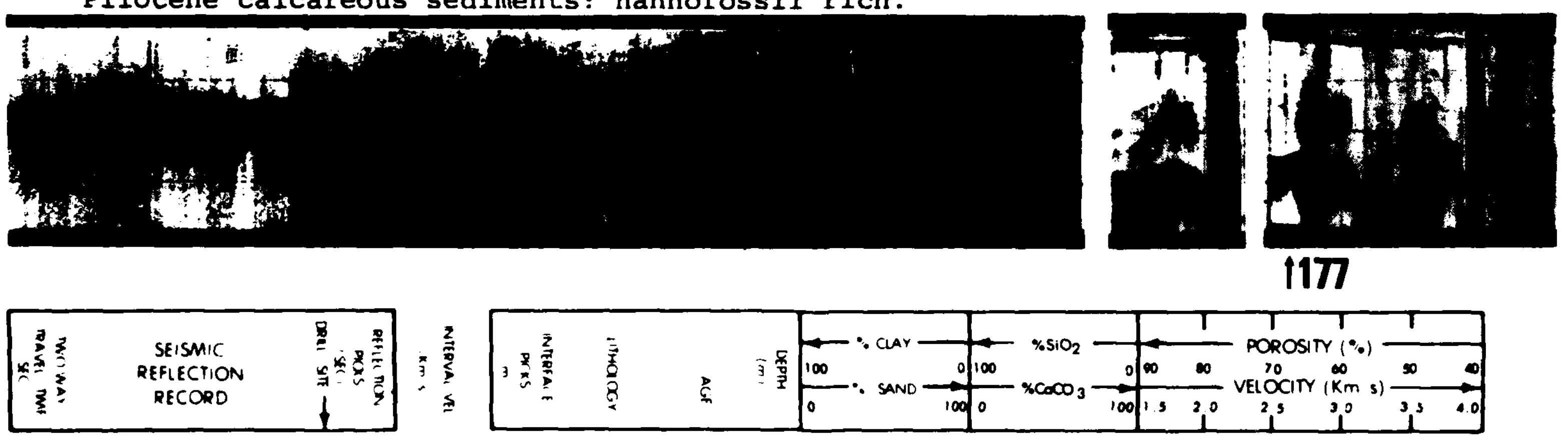
Position:
Latitude 50°28.2' N
Longitude 130°12.3' W
Date: 06/23/71
Time: 0140Z
Water depth: 2006 meters
Location: Paul Revere Ridge

CORE DATA

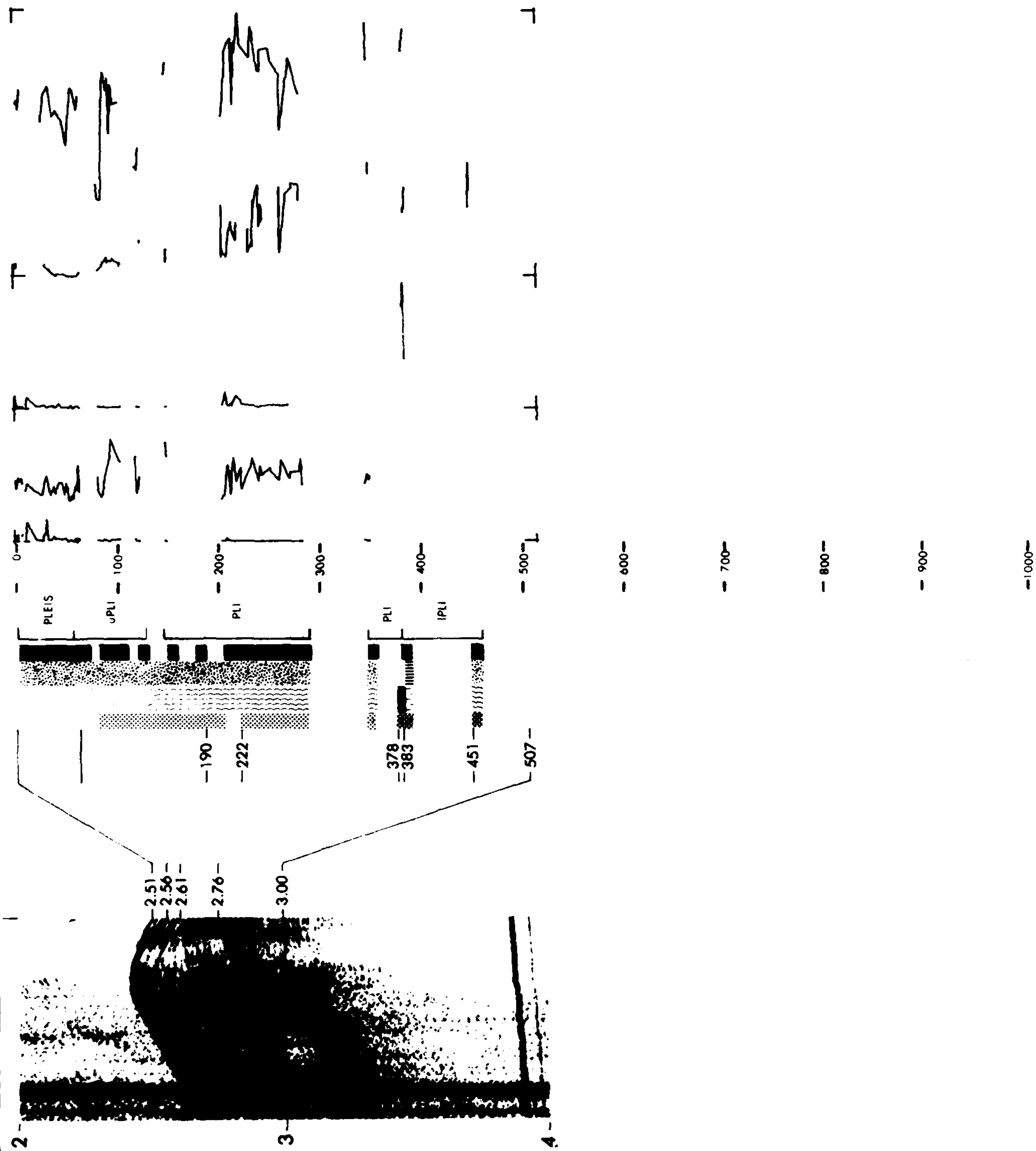
Penetration:	177	177A	
Drilled--	0	274	meters
Cored----	9	233	meters
Total----	9	507	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	1	26	cores
	9	136	meters

Poorly sorted, massive sands of Unit 7 were deposited as turbidites on the basement in a deep-sea fan environment some distance from the continent. As the fan developed, block faulting occurred over a broad regional front ponding the turbidites and leaving other areas above the general level of turbidite depositon. Lower Pliocene nannofossil-bearing silty clay and nannofossil ooze of Unit 6 represent hemipelagic and pelagic sedimentation on one of these slightly higher topographic areas. The tholeiitic basalt was probably intruded as a sill at a later date but prior to the late Pleistocene faulting since it is fractured. After a period of hemipelagic and pelagic deposition, turbidite deposition filled the basins between the continent, and Site 177 began to receive sand and silt turbidites once again (Unit 4). Another period (Unit 3) of pelagic sedimentation followed as further subsidence and basinal deepening occurred to the east. The upper Pliocene sand and silt turbidites of Unit 2 represent the final episode of turbidite deposition at this site. Uplift of Paul Revere Ridge commenced in the late Pliocene-early Pleistocene time. The fine-grained hemipelagic silty clays of Unit 1 were deposited. Thin, poorly sorted sand layers probably represent ice-rafting during the glacial periods of the Pleistocene.

Pliocene calcareous sediments: nannofossil rich.



SITE 177 LEG 18



SITE DATA

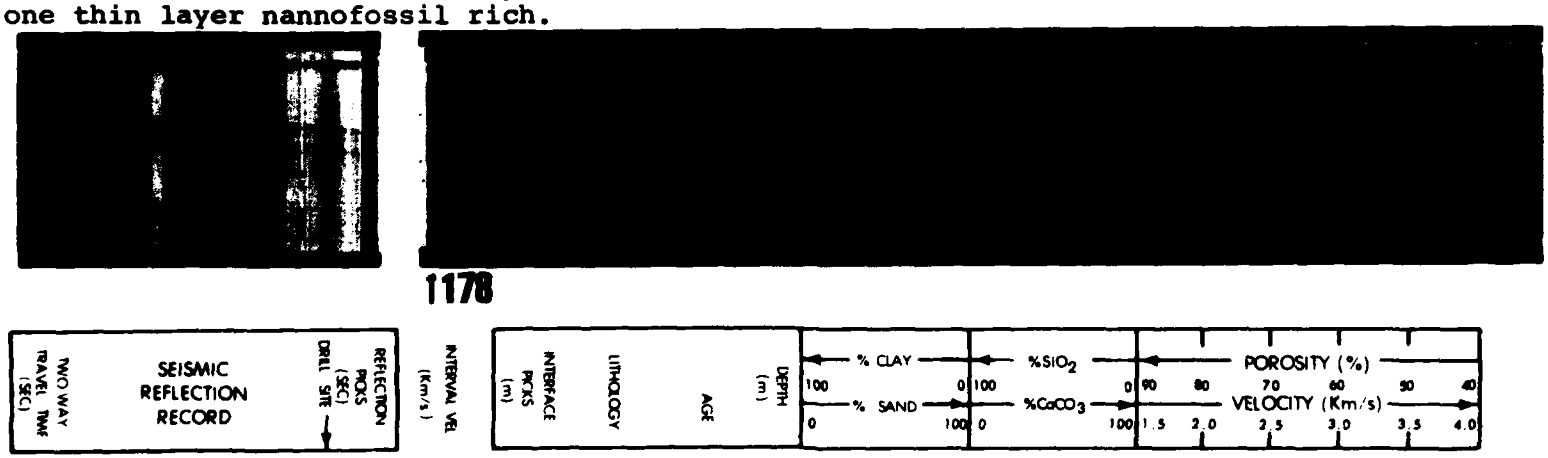
Position:
Latitude 56° 57.4' N
Longitude 147° 07.9' W
Date: 06/30/71
Time: 0340Z
Water depth: 4218 meters
Location: Alaskan Abyssal Plain

CORE DATA

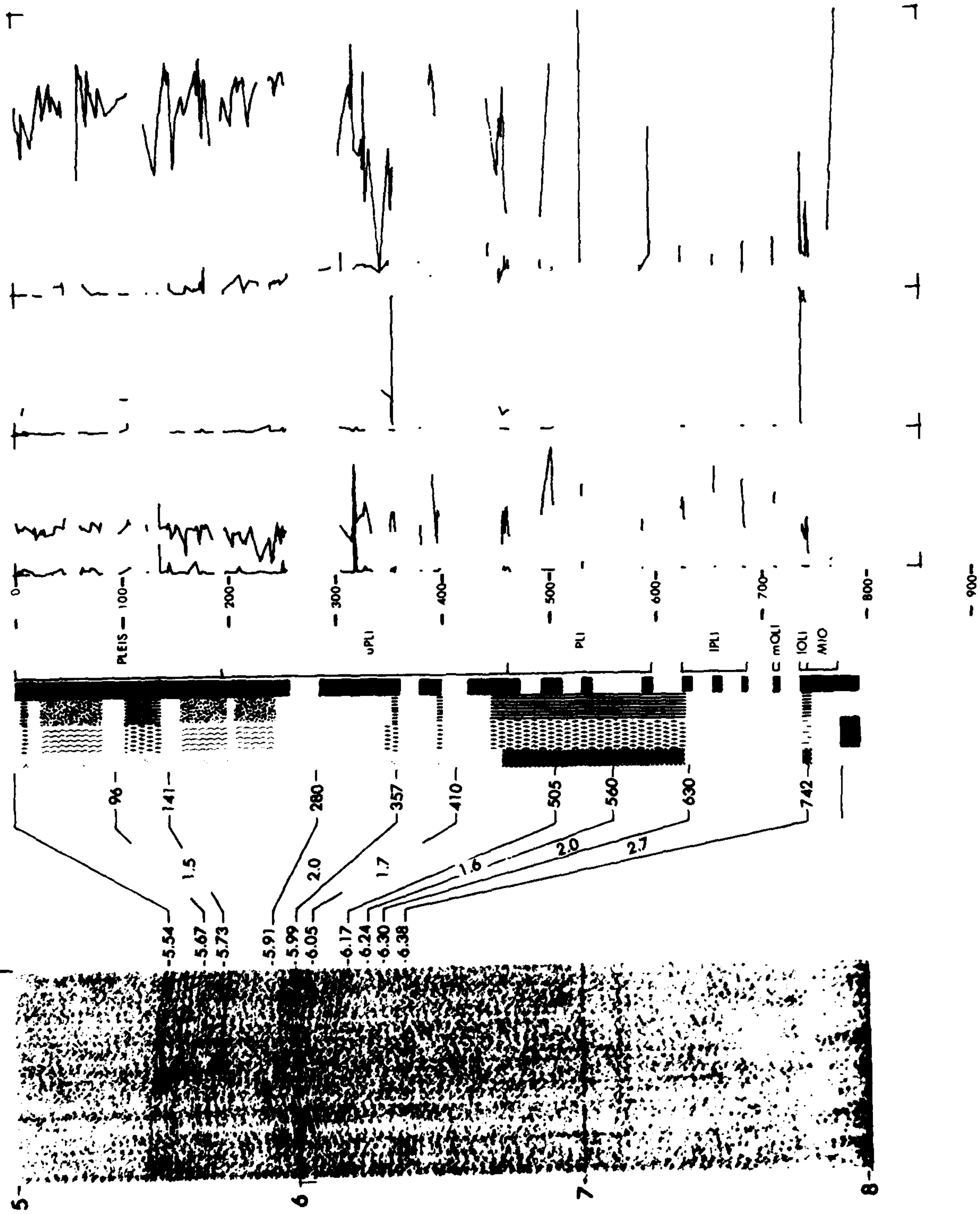
Penetration:
Drilled-- 275 meters
Cored---- 520 meters
Total---- 794 meters
Recovery:
Basement- 2 cores
.4 meters
Total---- 59 cores
212 meters

Core recovery was poor because of a malfunction in the bottom-hole assembly. Accordingly, the stratigraphic section is not well known, especially below 360 meters. The lower sequence indicates a typical abyssal environment and a sudden short interception of the bottom by the calcium carbonate compensation level. This lower Miocene depression of the compensation level may have been synchronous with major uplift of the Chugach-St. Elias Mountains. This may also have been a time when the Kula Ridge was being subducted (Atwater 1970). The intermediate sequence marks a change from the previous pelagic and hemipelagic sedimentation to turbidite sedimentation. It is a time of abyssal turbidity current channels broken by short periods of quiescence as marked by zones rich in diatoms. Continued uplift of the mountains fringing the Gulf of Alaska and short periods of mountain-valley glaciation may have provided changing types of sediment. An increasing proximity to land by westward plate movement may also be reflected in the lithology. The first volcanic ash, possible from the Alaska Peninsula, is in the upper Miocene section. The upper sequence reflects strong glaciation and the uppermost 100 meters indicate exceedingly rapid denudation on land.

Siliceous sediment mostly diat
one thin layer nannofossil rich.



SITE 178 LEG 18



SITE DATA

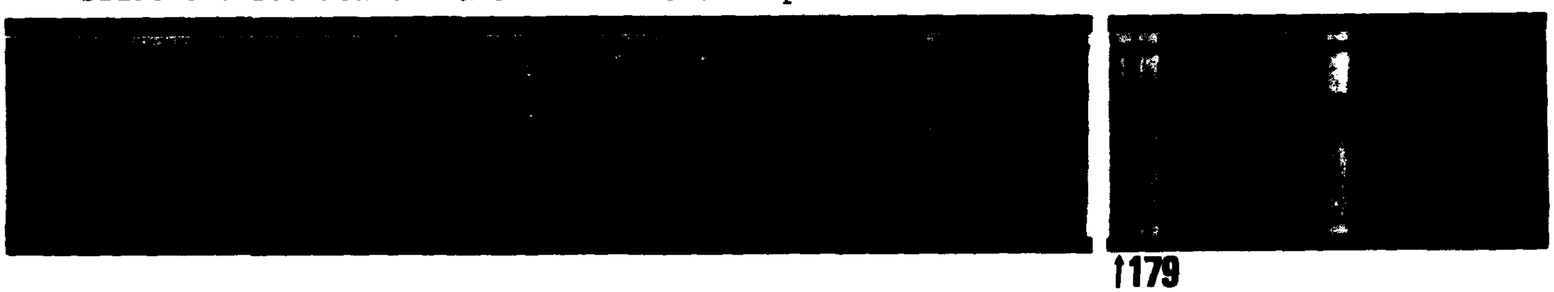
Position:
Latitude 56°24.5' N
Longitude 145°59.3' W
Date: 07/06/71
Time: 1900Z
Water depth: 3781 meters
Location: East flank of Giacomini Guyot

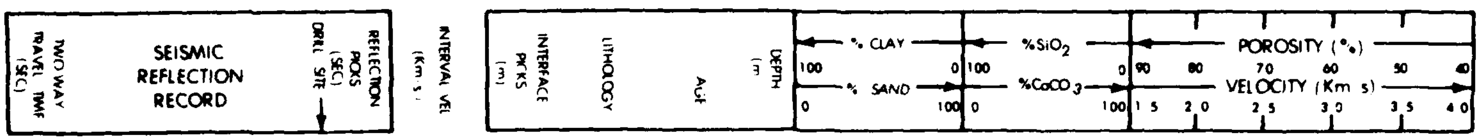
CORE DATA

Penetration:		
Drilled--	0	meters
Cored----	109	meters
Total----	109	meters
Recovery:		
Basement-	0	cores
	0	meters
Total----	13	cores
	70	meters

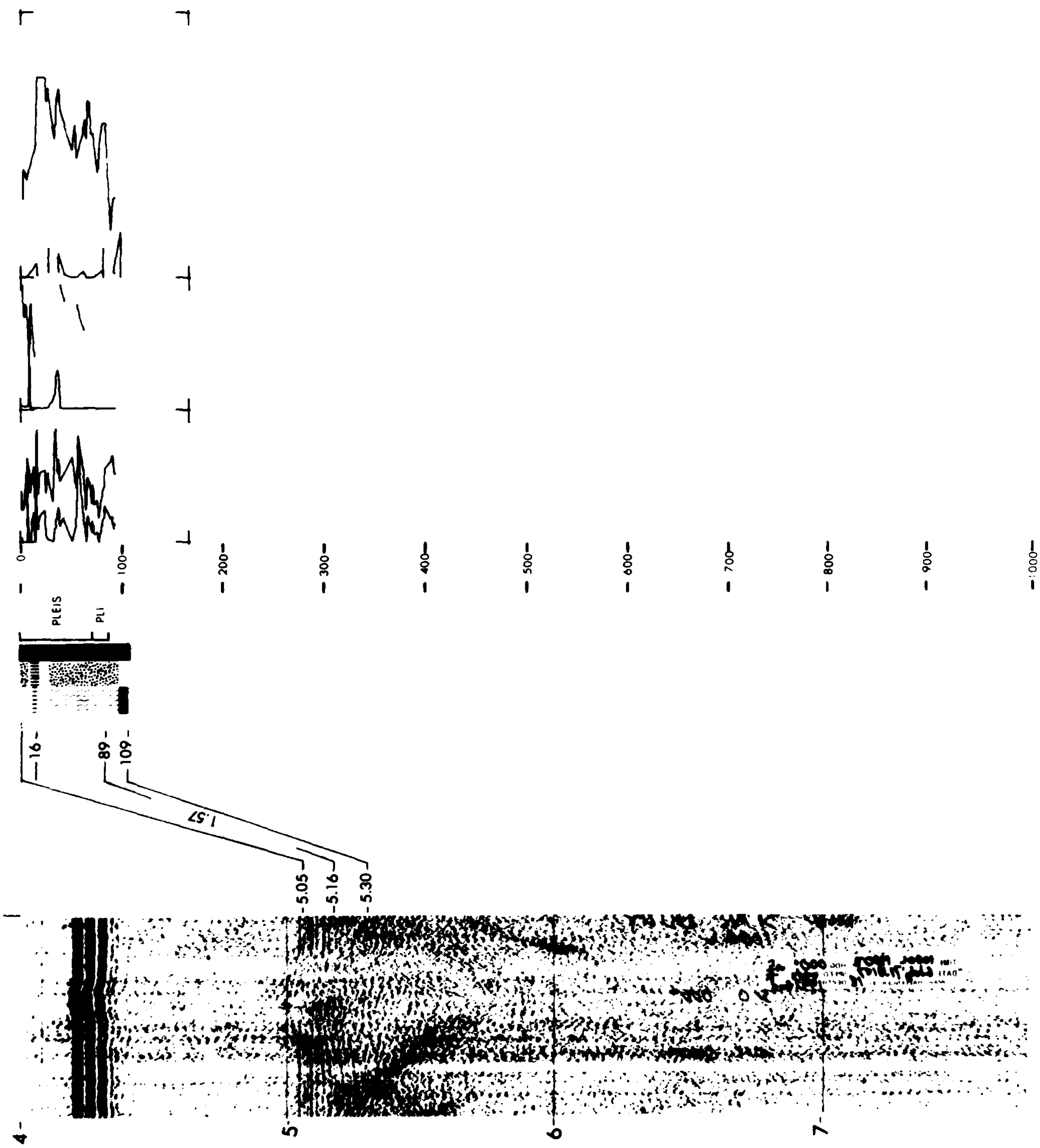
A 109-meter sediment section continuously cored at this site is divided into 3 units. The first unit (0-16m) consists of gray muds with diatoms, and 5- to 45-cm-thick beds of graded silts and sands rich in microfossils. Occasional ash beds, as well as rare pebbles, probably glacial erratics, occur within this unit. The second unit (16-89m) is a gray to green mud with limited amounts of biogenous material. The upper coarse sediments have a large biogenous component which diminishes downward thus becoming true detrital sands and silts. Abundant glacial erratics, and rare ash layers also occur in this unit. The third unit (89-108m) is mainly a zeolitized ash-bearing clay which contains a thick graded bed of glassy volcanic clasts. A fragmented weathered olivine basalt occurs below these heterogenous deposits. The basalt is an oceanic type, vesicular and deeply weathered. It was possibly transported downslope from Giacomini Guyot. Although Site 179 is elevated above the Alaska Abyssal Plain, turbidites are still interbedded with the pelagic and hemipelagic sediments, but they represent a smaller percentage of the sedimentary column than at Site 178. Pleistocene sedimentation rates indicate the strong influence of turbidity current deposition on the Alaska Abyssal Plain during this period.

Siliceous sediments diatom rich. One sample of detrital sediment silica fossil rich.





SITE 179 LEG 18



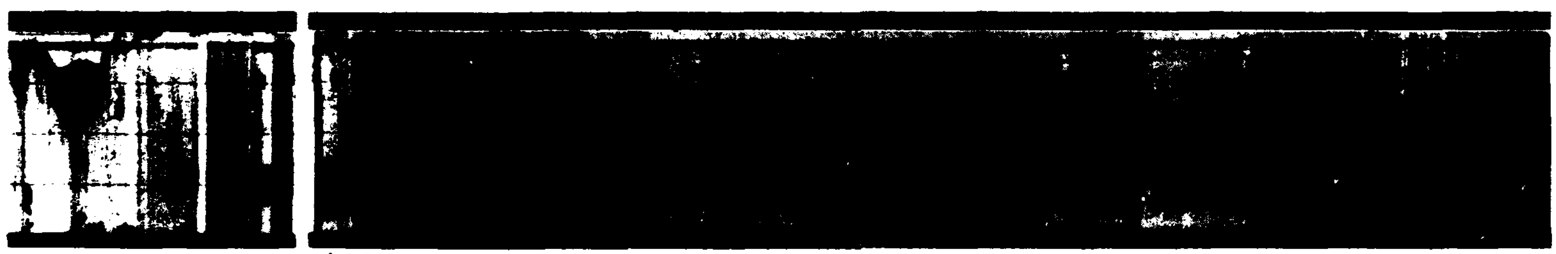
SITE DATA

Position:
Latitude 57°21.8' N
Longitude 147°51.4' W
Date: 07/08/71
Time: 2102Z
Water depth: 4923 meters
Location: Eastern Aleutian Trench

CORE DATA

Penetration:
Drilled-- 233 meters
Cored---- 238 meters
Total---- 470 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 25 cores
82 meters

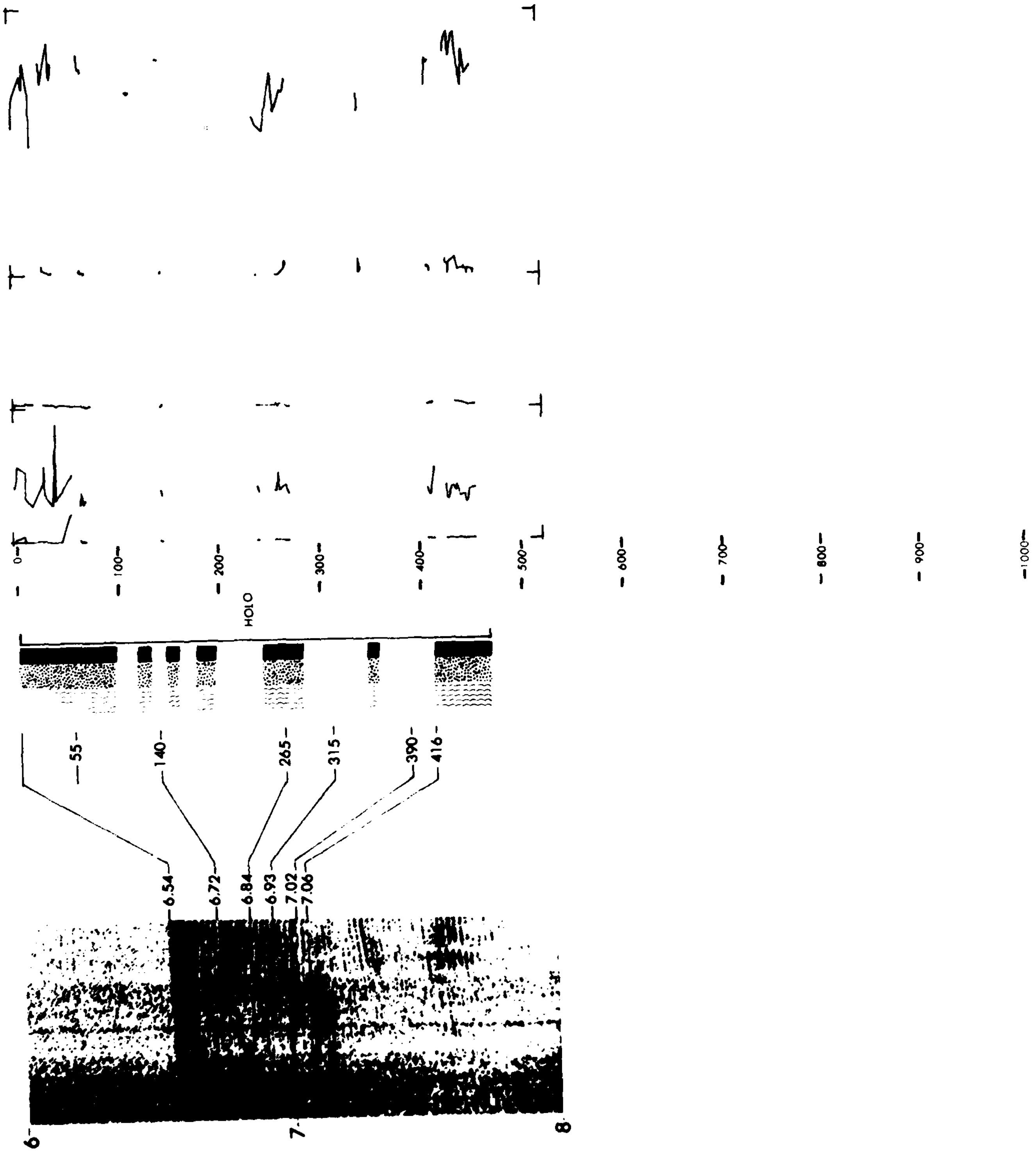
The section consists of graded silt turbidites and interbedded muds with silt laminae that are possibly turbidites. Variations in the amount of silt and the presence of ice-rafted erratics provides a basis for dividing the section into seven units. Foraminifers, calcareous nannofossils, and diatoms were found in varying amounts throughout much of the section; radiolarians are rare. The ash at the top of the section is presumed to be from the 1912 eruption of Mt. Katmai because this is a frequent occurrence in the western Gulf of Alaska. The most intense glaciation, as indicated by the size and number of erratics, occurs in Unit 6 at the bottom of the trench fill. This may correspond to the intense glacial period between 0.22 and 0.28 m.y. Sedimentation in the trench during Holocene time has probably been relatively low because glacial and fluviatile sediments have been trapped in fjords or have built deltas on the continental shelf whereas during intense glaciation both ice and streams entered the sea near the shelf break. The large quantities of fine sediments at Site 180 may be overbank deposits associated with the turbidity current channel even though it is 8 km away. Coarser sediment may be concentrated along the channel.



180

TWO-WAY TRAVEL TIME (SEC)
SEISMIC REFLECTION RECORD
DRILL SITE
REFLECTION PICKS SEC
INTERVAL VEL Km/s
INTERFACE PICKS (m)
LITHOLOGY
AGE
DEPTH (m)
% CLAY 100 0
% SAND 0 100
%SiO$_2$ 100 0
%CaCO$_3$ 0 100
POROSITY (%) 90 80 70 60 50 40
VELOCITY (Km/s) 1.5 2.0 2.5 3.0 3.5 4.0

SITE 180 LEG 18



SITE DATA

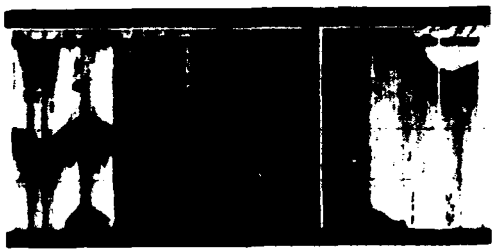
Position:
Latitude $57^\circ 26.3'$ N
Longitude $148^\circ 27.9'$ W
Date: 07/11/71
Time: 1900Z
Water depth: 3086 meters
Location: Ridge within Aleutian Trench

CORE DATA

Penetration:
Drilled-- 110 meters
Cored---- 260 meters
Total---- 369 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 30 cores
106 meters

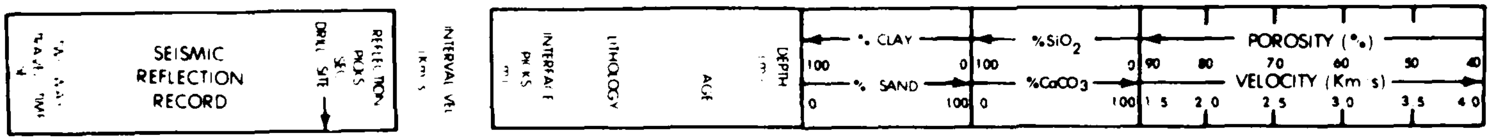
The upper two units are probably mildly deformed lower continental slope deposits that contain displaced microfossils. The 40 to 50 cm thick foram-rich clayey silt at the top of the core indicates a period during which the site was beyond the reach of turbidity currents or slumps. However, a clean graded sand only 70 cm down the hole marks the first of many such layers farther down. These layers indicate that the site was on a continuous slope in the path of turbidity currents or slumps rather than in its present position on the side of an isolated knoll. The maximum age of the deformation which isolated the site from the rest of the slope is given by the 0.26 m.y. diatom age at 104 meters. The sudden change between undeformed sediments of Unit 2 and deformed sediment of Unit 3 indicates a tectonic contact between them. Since the radiolaria in the lower part of Unit 2 indicate an age less than 0.4 m.y. and the diatoms in the upper part of Unit 3 indicate an age no less than 0.92 m.y., the hiatus is at least 0.5 m.y. The unusual sediment cored at this site was most probably deformed, dewatered, and compacted through tectonism rather than by syn-sedimentary processes or slumping.

Siliceous sediments diatom rich. One thin layer in Holocene time; detrital.

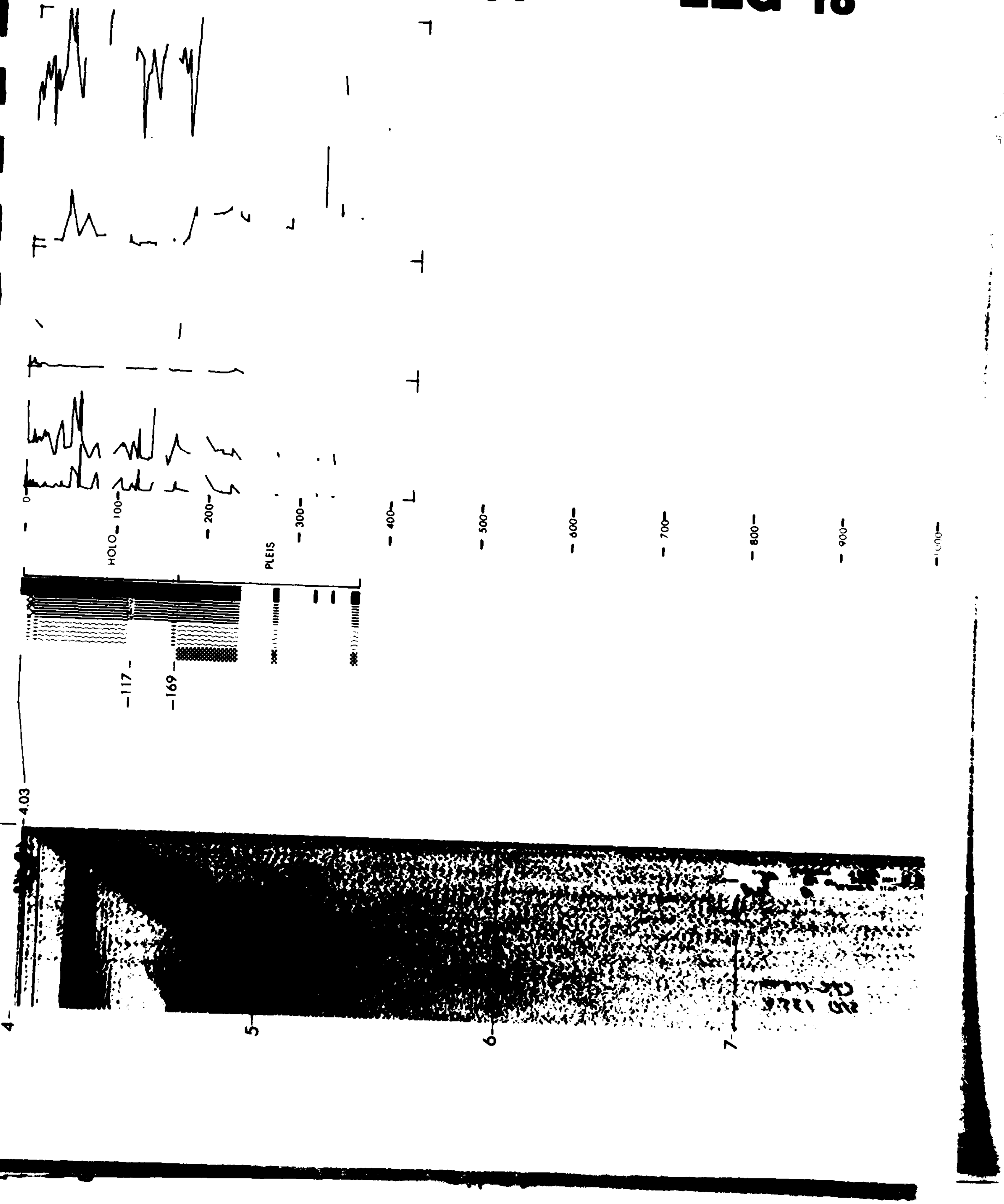


1182

1181



SITE 181 LEG 18



SITE DATA

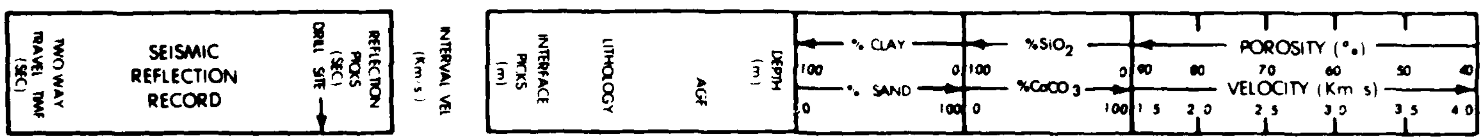
Position:
Latitude $57^\circ 53.0'$ N
Longitude $148^\circ 43.0'$ W
Date: 07/15/71
Time: 1944Z
Water depth: 1419 meters
Location: Continental Slope
off Kodiak Island

CORE DATA

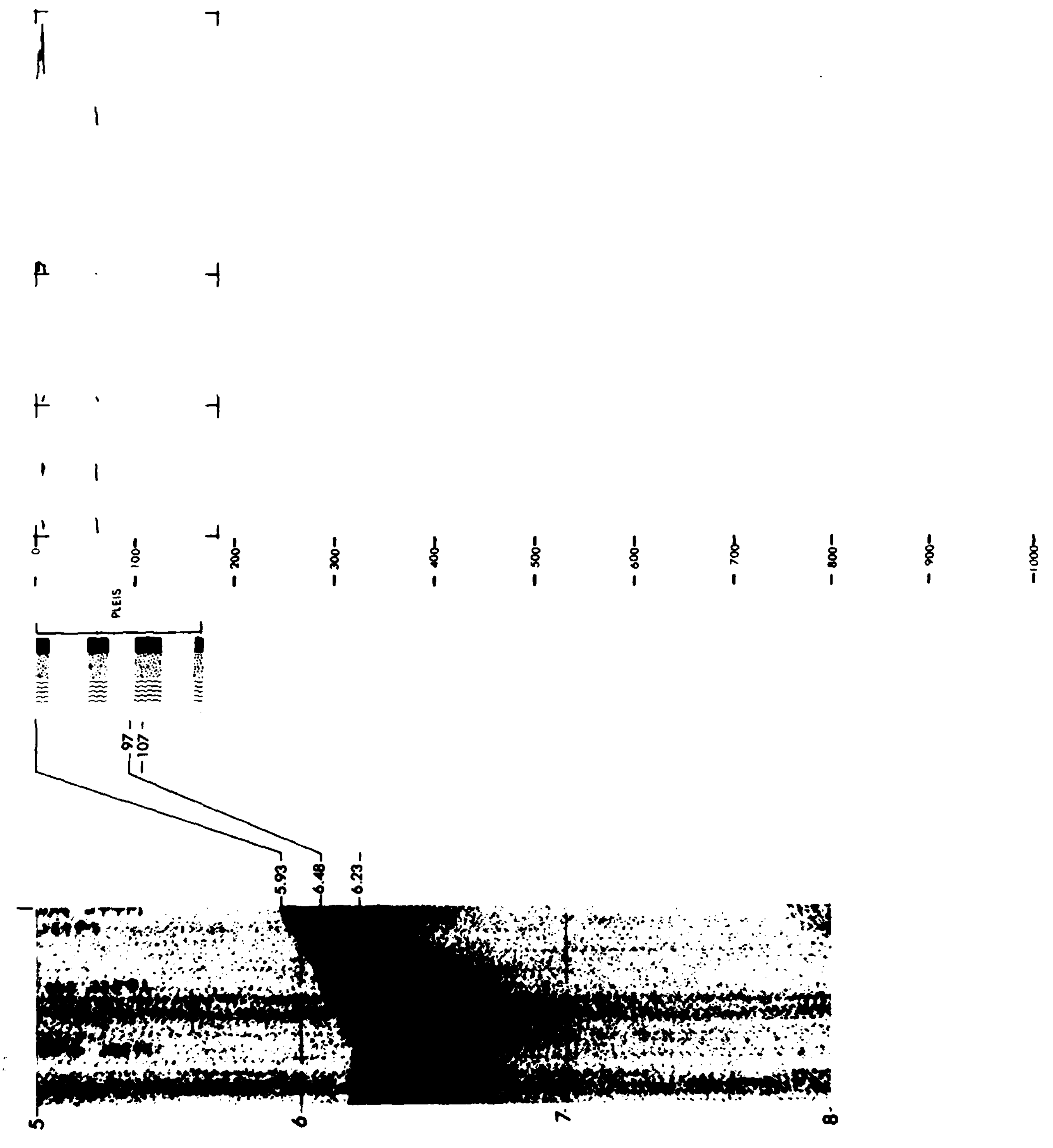
Penetration:	182	182A	
Drilled--	69	188	meters
Cored----	54	7.5	meters
Total----	123	195	meters
Recovery:			
Basement-	0	0	cores
	0	0	meters
Total----	6	1	cores
	12	.03	meters

An attempt was made to obtain a biostratigraphic section above the calcium carbonate compensation depth for this high-latitude region. After two days of slow drilling **GLOMAR CHALLENGER** was unable to hold position in bad weather and the site was abandoned. A rough stratigraphic column was constructed from the small amount of core recovered. All sediments were poorly sorted clayey silts with some sand and pebbles (glacial erratics), except for one core catcher containing a well-sorted fine sand. Detailed correlation with seismic reflection records suggest that the pebbly muds make up the upper 95 meters of the section whereas extensive sands are present below. Based upon poor to well-preserved microfossils, the oldest sediment encountered is from 0.92 to 1.3 m.y. old. Displaced shelf-edge and upper bathyal benthonic foraminifers are found throughout the section as well as in situ middle bathyal species. Pliocene planktonic and benthonic specimens reworked from exposures on the adjacent shelf were found near the bottom of Hole 182. The tectonic significance of findings at this site include the possible age of acoustic basement (Pliocene-late Miocene) and the vigorous erosion of a shelf break arch in early Pleistocene time.

1182



SITE 182 LEG 18



SITE DATA

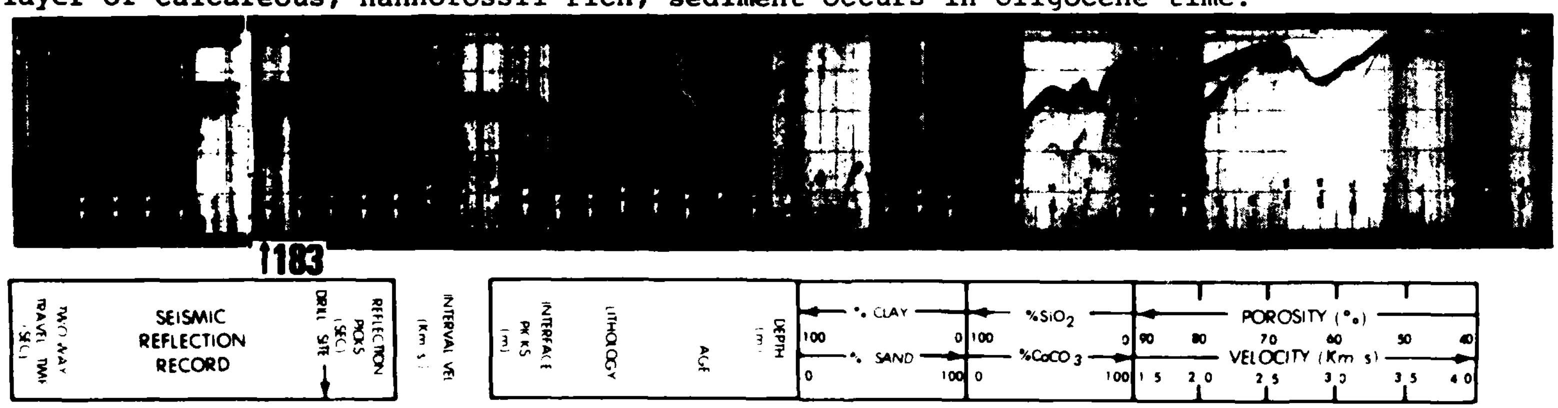
Position:
Latitude 52° 34.3' N
Longitude 161° 12.3' W
Date: 07/24/71
Time: 1830Z
Water depth: 4708 meters
Location: Aleutian Abyssal Plain; Gulf of Alaska

CORE DATA

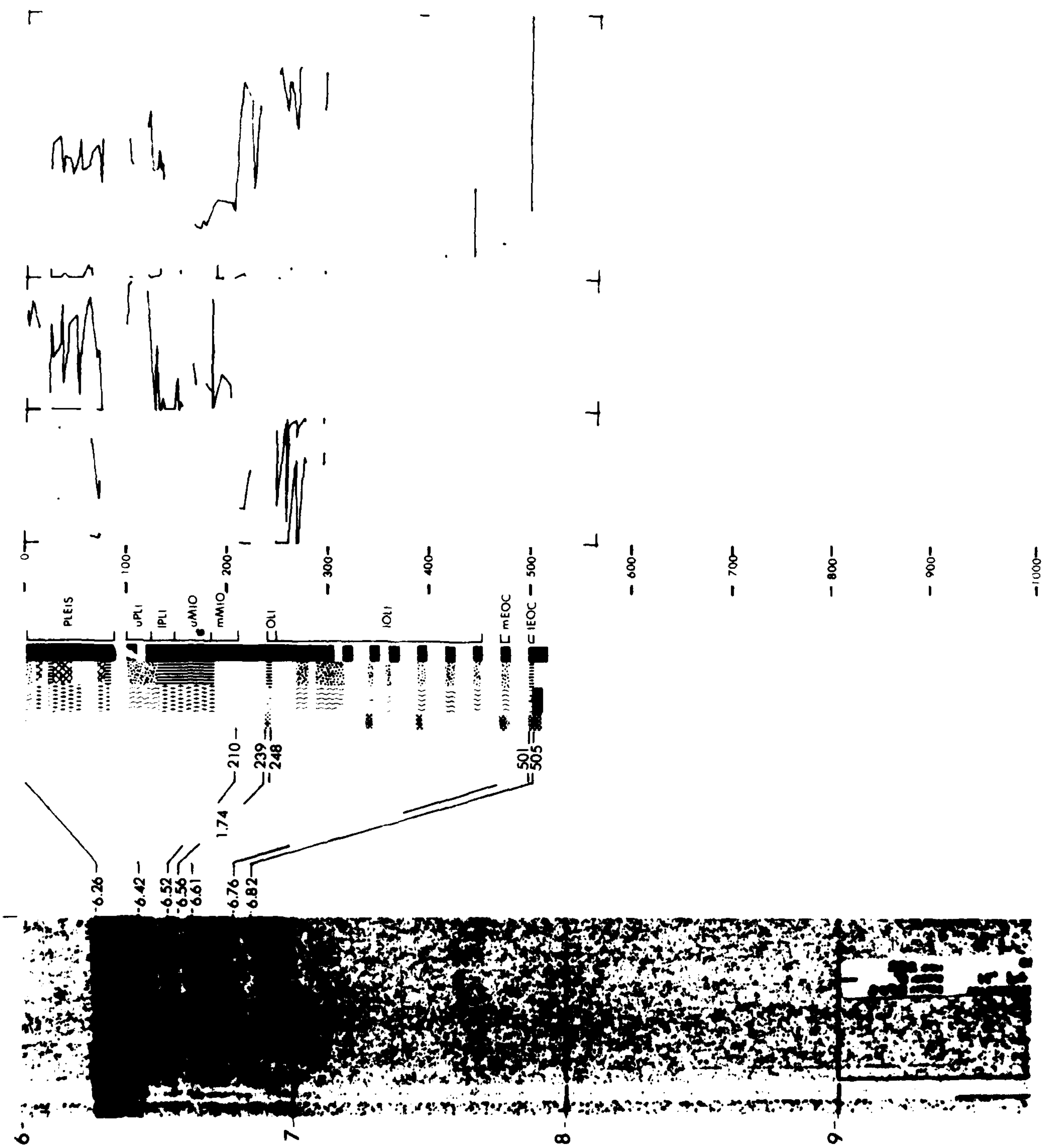
Penetration:
Drilled-- 155 meters
Cored---- 361 meters
Total---- 516 meters
Recovery:
Basement- 2 cores
.03 meters
Total---- 40 cores
150 meters

Both the Oligocene and lower Eocene carbonate beds are bounded by pelagic clays, not turbidites, and may be considered autochthonous, indicating two downward incursions of carbonate compensation depth during this interval. The upper chalk, apparently somewhat older than the one encountered at Site 178 of Leg 18, was probably deposited at approximately 5 km below sea level. Eocene turbidite beds; the dominant species is geographically wide ranging and also occurs in beds of late Eocene age on nearby Adak Island, Aleutians. The oldest dateable sediment above the alkali olivine basalt (late early Eocene) is approximately 12 m.y. younger than the probable age of the basalt as indicated by the associated magnetic anomaly (24). Although uncertainties remain, the occurrence of geothite-bearing calcareous ironstone and pyrite-bearing unfossiliferous aragonitic limestone, factors implying precipitation in hot brines rather than hydrothermal alteration of pelagic deposits, suggests that the age disparity is not due to intrusion of basalt into Eocene deposits. If this is true, then perhaps the 12-m.y. hiatus can be related to nondeposition during the Paleocene, a circumstance commonly observed in the Pacific and also found at Site 192 (Meiji Guyot), or to the nonrecovery of Paleocene beds in the final core (39) containing sediment.

Interbedded detrital sediment and siliceous, radiolaria rich, sediments. One thin layer of calcareous, nannofossil rich, sediment occurs in Oligocene time.



SITE 183 LEG 19



SITE DATA

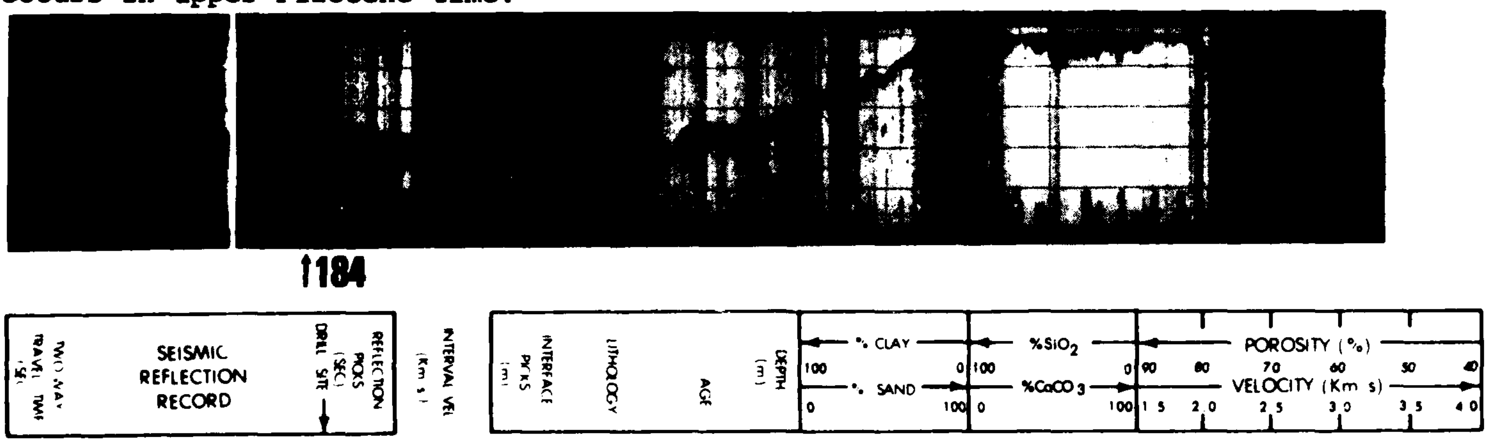
Position:
Latitude 53°42.6' N
Longitude 170°55.4' W
Date: 07/30/71
Time: 0515Z
Water Depth: 1910 meters
Location: Umnak Plateau; Bearing Sea

CORE DATA

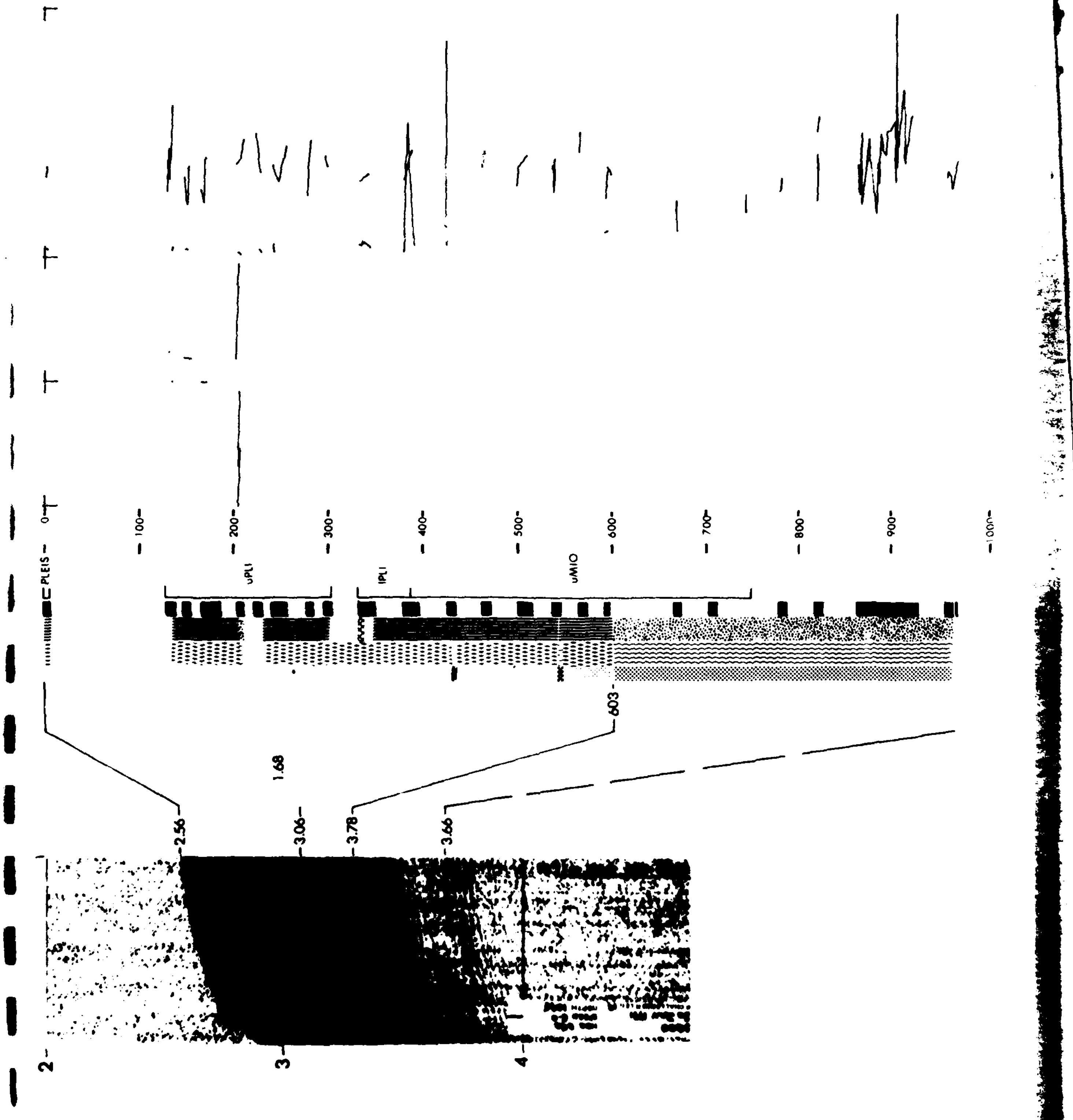
Penetration:	184	184A	184B	
Drilled--	417	669	852	meters
Cored----	186	0	121	meters
Total----	603	669	973	meters
Recovery:				
Basement-	0	0	0	cores
	0	0	0	meters
Total----	23	0	14	cores
	123	0	50	meters

Unit A consists of clay-rich diatom ooze (0-603 m) with a variable admixture of sand and silt layers, volcanic ash beds, and pumice pebbles. The microflora is typical of a neritic environment in the Pliocene section. Unit B (603-973 m) is a sparsely fossiliferous clayey siltstone (or mudstone) with sporadic occurrences of typically non-age diagnostic coccoliths and diatoms, and foraminifera. Thin beds of calcite- and silica-cemented (?) size-graded, volcanic sandstone and siltstone and lithified glass ash are present. The occurrence of neritic diatoms in beds of Pliocene age is of considerable interest because it implies cycles of uplift and subsidence of Umnak Plateau. However, the cooccurrence of deep-water foraminifera, and the absence of lithofacies typical of a shelf environment, indicate that the neritic flora is allochthonous and presumably derived from the summit platform of the nearby Aleutian Ridge, possibly during episodes of glacially lowered sea level or tectonic elevation of the ridge. The finding of Melonis ponpilioides in diatomaceous beds of late Miocene age, and again in slightly older beds within the underlying mudstone sequence, suggests that the Umnak Plateau has remained at or below its present summit depth (near 2000 m) during the last 8 to 10 m.y.

Siliceous sediment; radiolaria rich. One thin layer of detrital, mica rich, sediment occurs in upper Pliocene time.



SITE 184 LEG 19



SITE DATA

Position:
Latitude 54°25.7' N
Longitude 169°14.6' W
Date: 08/05/71
Time: 0505Z
Water depth: 2110 meters
Location: Flank of Bering Canyon

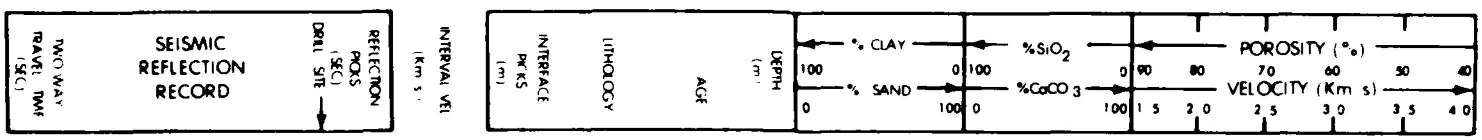
CORE DATA

Penetration:
Drilled-- 512 meters
Cored---- 216 meters
Total---- 728 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 27 cores
98 meters

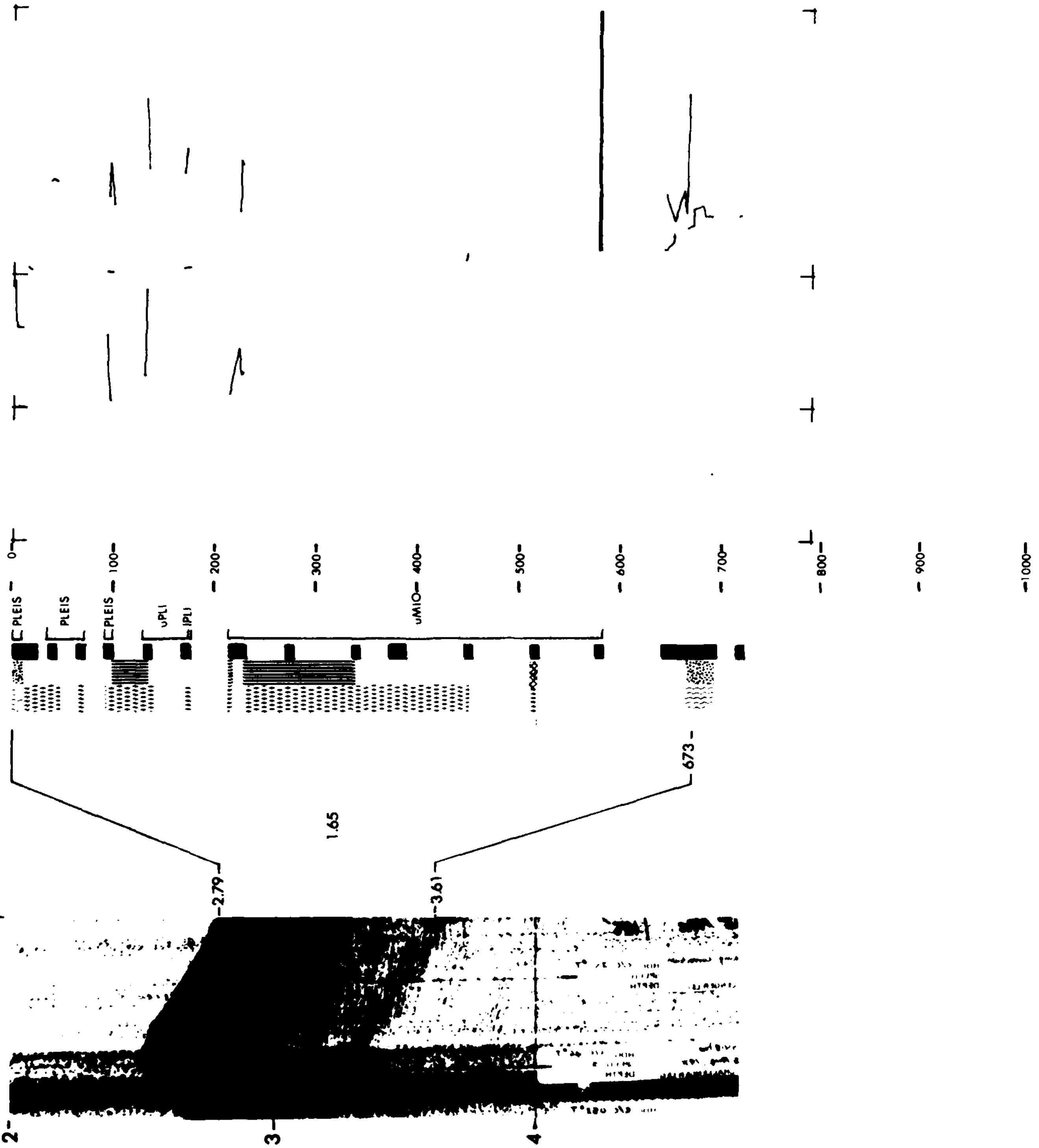
The drilled and cored sedimentary sequence consists of 728 meters of Holocene, Pliocene, and upper Miocene hemipelagic clay-rich diatom ooze and diatomaceous silty clay or clayey silt. Thin, terrigenous sand and silt beds, a few ash layers, and some limestone beds also occur. A gradual decrease in diatom content and enrichment in clay takes place between 600 meters and 728 meters. The terrigenous fraction is most likely derived from a terrane underlain by volcanic rocks or rocks rich in volcanic debris. The upper portion of the section (above 250 m at Core 10) contains discrete beds of pyroclastic and volcanoclastic debris composed of glass- and feldspar-rich sand and sandy silt, thin ash layers, scattered erratics, and pumice fragments. Additionally, above 250 meters the section locally contains up to 20 percent glass as a constituent of the terrigenous fraction. Unlike Site 184, only a few neritic diatoms occur and these are scattered throughout the sediment sequence.

Siliceous sediment; diatom rich, one thin layer spicule rich.

↑185



SITE 185 LEG 19



SITE DATA

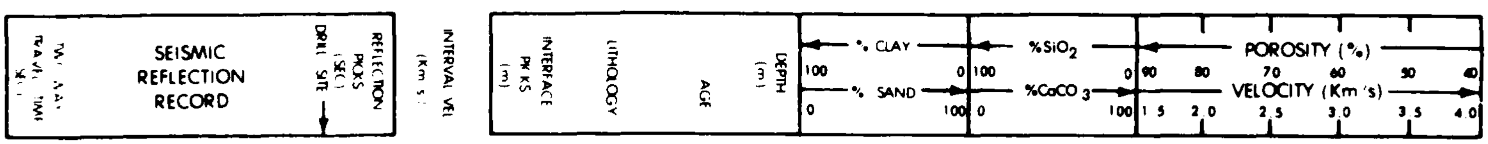
Position:
    Latitude   51°07.8' N
    Longitude 174°00.3' W
Date: 08/09/71
Time: 1225Z
Water depth: 4522 meters
Location: Atka Basin

CORE DATA

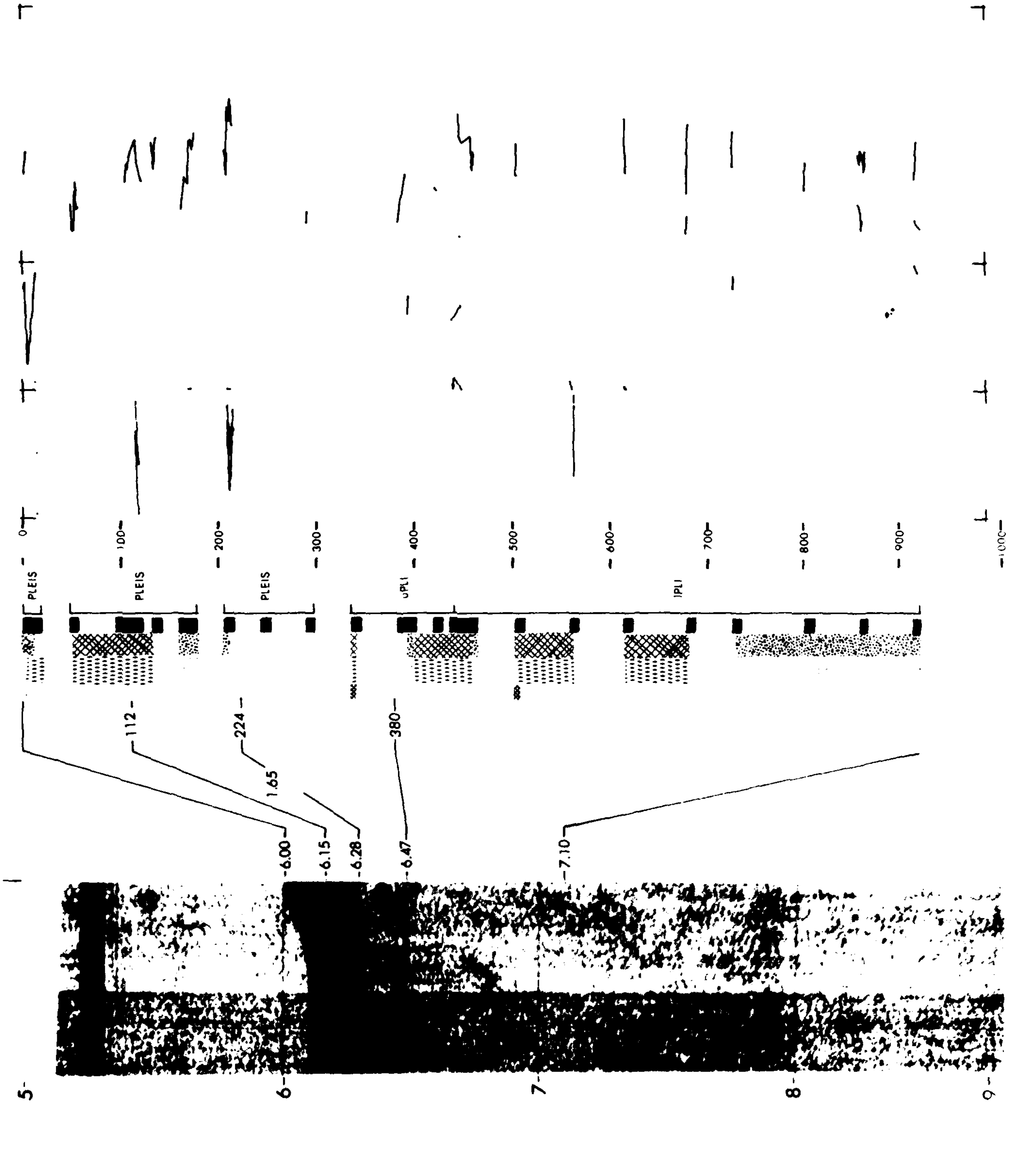
Penetration:
    Drilled-- 681 meters
    Cored---- 245 meters
    Total---- 926 meters
Recovery:
    Basement-   0 cores
                0 meters
    Total---- 28 cores
              143 meters

The sediment sequence penetrated is 926 meters thick and consists predominantly of diatomaceous silty clay ranging in age from late Pleistocene through early Pliocene. A section (at 622 m) less than 60 meters thick of middle Miocene diatomaceous silty clay is enclosed within a larger section of lower Pliocene silty clay. The microfossils, which include calcareous forms, suggest that the middle Miocene unit is an allochthonous block. Reworked middle Miocene forms also occur in the associated Pliocene beds. Volcanic ash is interbedded throughout the section and ash beds are particularly common above 20 meters. A middle Pleistocene pumice-bearing ash layer 4.5 meters thick occurs at 165 meters. Beds of sand and silt up to 4.5 meters thick are commonly intercalated in the diatomaceous silty clay. Benthic foraminifera in the thick sandy layer of Cores 10 to 11 (middle to lower Pleistocene) are apparently displaced from shallower depths and imply that the sands are turbidites. Thin layers of calcite-cemented siltstones and diatomaceous, calcitic silt are present in the middle Pliocene between 386 and 509 meters.

Siliceous sediment; diatom rich. Detrital sediment; occasionally mica rich.



SITE 186 LEG 19



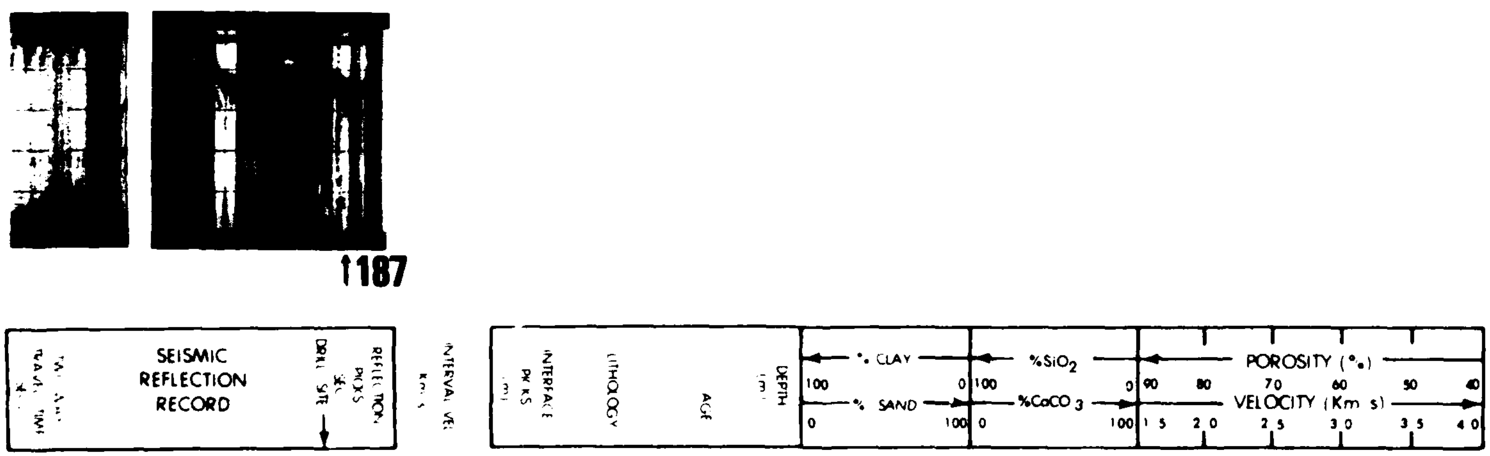
SITE DATA

Position:
Latitude $51^\circ 06.6'$ N
Longitude $173^\circ 57.2'$ W
Date: 08/13/71
Time: 1300Z
Water depth: 4567 meters
Location: Alka Basin

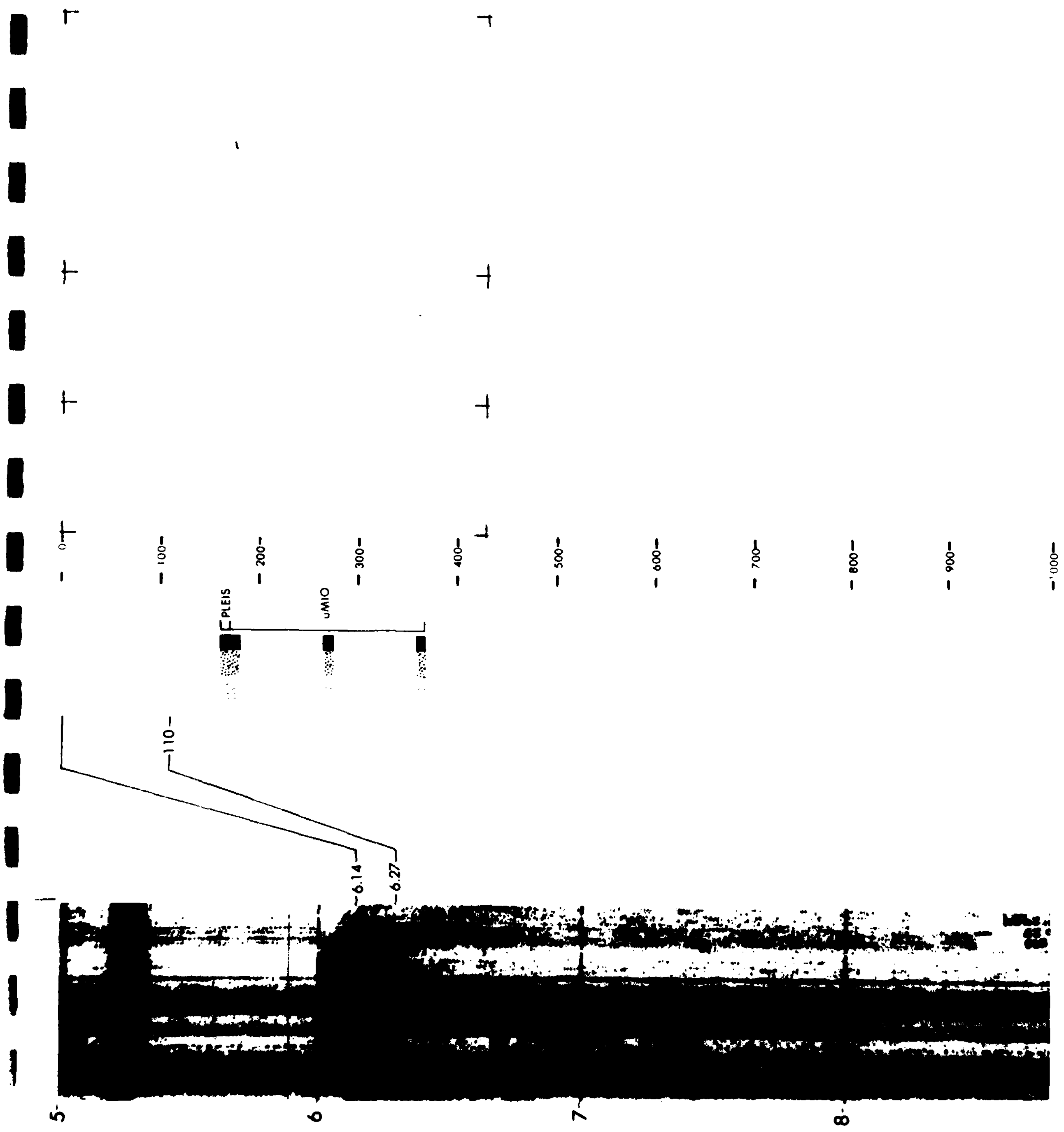
CORE DATA

Penetration:
Drilled-- 334 meters
Cored---- 36 meters
Total---- 370 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 4 cores
6.8 meters

The deposits recovered from Site 187 are dark brownish gray and olive gray diatomaceous silty clay, identical to those recovered at Site 186. An ice-rafted (?), rounded pebble of graywacke was recovered from the core catcher in the Interval 164 to 173 meters along with mud of early Pliocene age and two angular pieces of lower Pleistocene limestone (one of which included fecal pellets) probably derived from higher levels. In Core 2 a light gray vitric ash was recovered (174 m) in beds of late Miocene age. The final core recovered from 361 to 370 meters contains highly disturbed layers of brittle claystone in an otherwise soft section of diatomaceous silty clay. At least part of the acoustic basement is deformed sedimentary rock as old as late Miocene. These deposits presumably accumulated in Atka Basin. Near Site 186, beneath this basin, stratigraphically equivalent beds lie deeper than 926 meters. The structural displacement of late Miocene beds between Sites 186 and 187 must be at least 750 meters. The source area for the allochthonous block of middle Miocene silty clay cored at Site 186 in beds of early Pliocene age is presumably the ridge drilled at Site 187.



SITE 187 LEG 19



SITE DATA

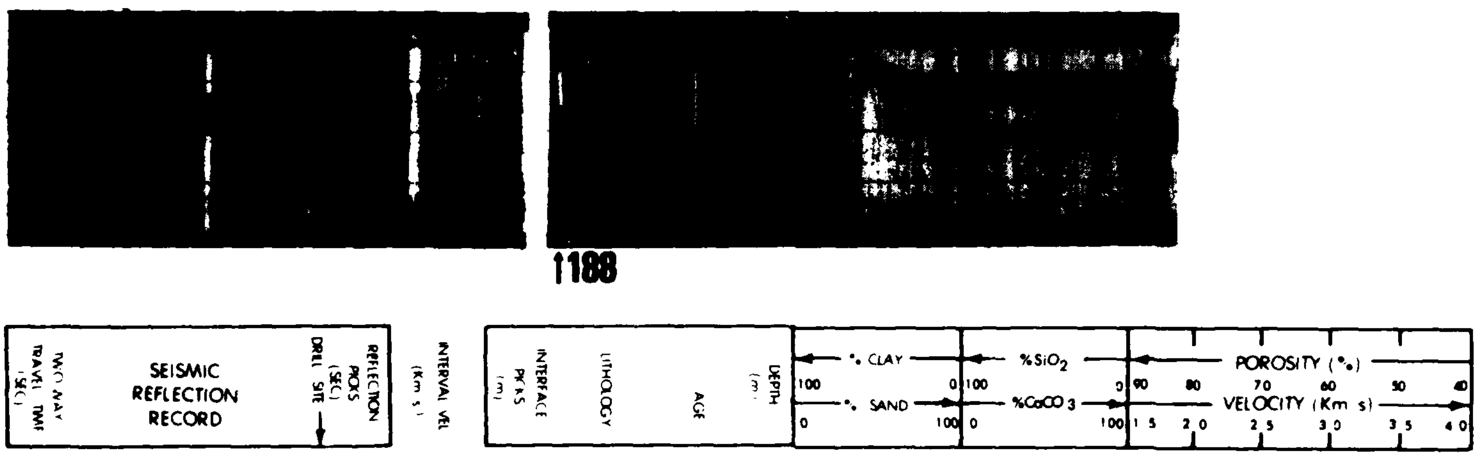
Position:
Latitude 53° 45.2' N
Longitude 178° 39.6' E
Date: 08/15/71
Time: 0258 Z
Water depth: 2649 meters
Location: Bowers Ridge;
Bearing Sea

CORE DATA

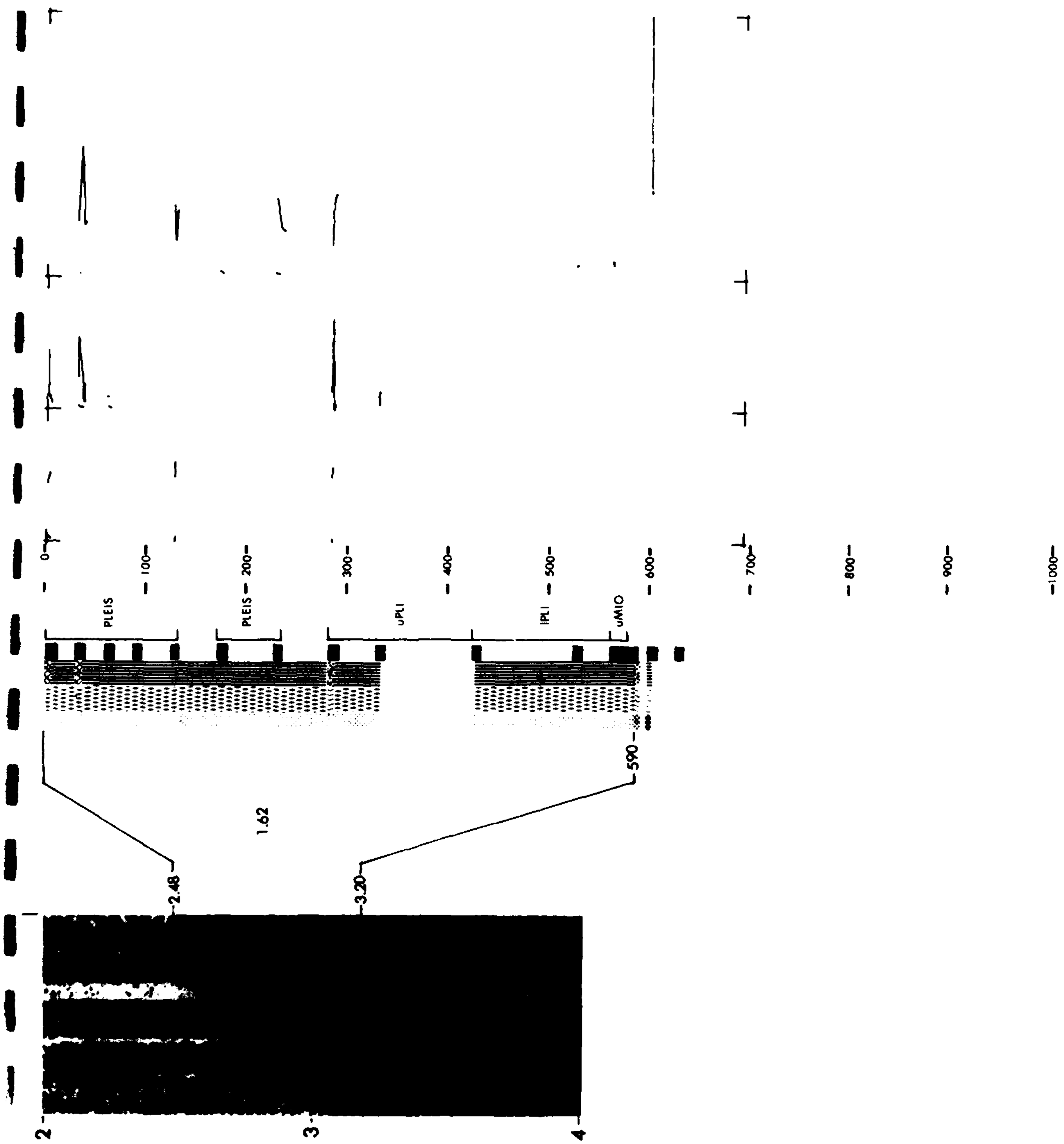
Penetration:
Drilled-- 492 meters
Cored---- 146 meters
Total---- 638 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 18 cores
57 meters

The 638-meter thick sedimentary sequency drilled and cored consists basically of a Pleistocene to upper upper Miocene (0-580 m) unconsolidated and semiconsolidated interbedded diatom ooze, silt-rich diatom ooze, and diatomaceous silt overlying mudstone (580-638 m) lacking diagnostic fossils. The upper diatomaceous unit is similar to Unit A at Sites 184 and 185, and the lower is similar to the mudstone sequence, Unit B, at Site 184. Variations in the relative abundance of diatoms and inorganic silt plus thin layers of volcanic ash, black sand and silt, and limestone occur throughout the upper 580 meters. Foraminiferal assemblages are typical of present water depths. Except for a few thin sand layers, no evidence of turbidite deposition was encountered at Site 188, hence it seems unlikely that any part of the Neogene section was deposited beneath the abyssal floor of the adjacent Bowers Basin. Thus, the drilled section at Site 188 appears to be an in situ pelagic and terrigenous blanket depositionally draped over a deeper basement underlying the inner flank of Bowers Ridge (Ludwig et al., 1971a).

Siliceous sediment; diatom rich, rarely radiolaria rich. One thin layer of detrital sediment occurs in upper Pliocene time.



SITE 188 LEG 19



SITE DATA

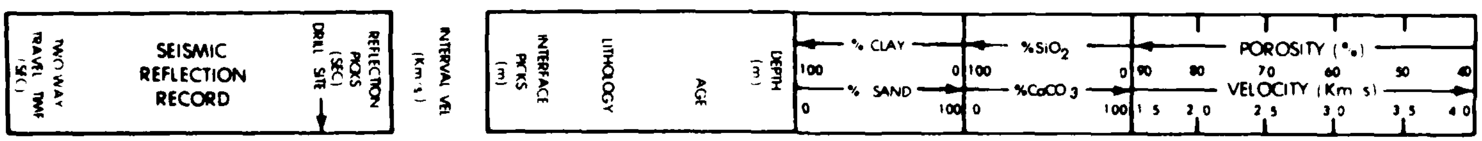
Position:
Latitude 54°02.1' N
Longitude 170°13.4' E
Date: 08/22/71
Time: 0714Z
Water depth: 3437 meters
Location: Aleutian Ridge; Bearing Sea

CORE DATA

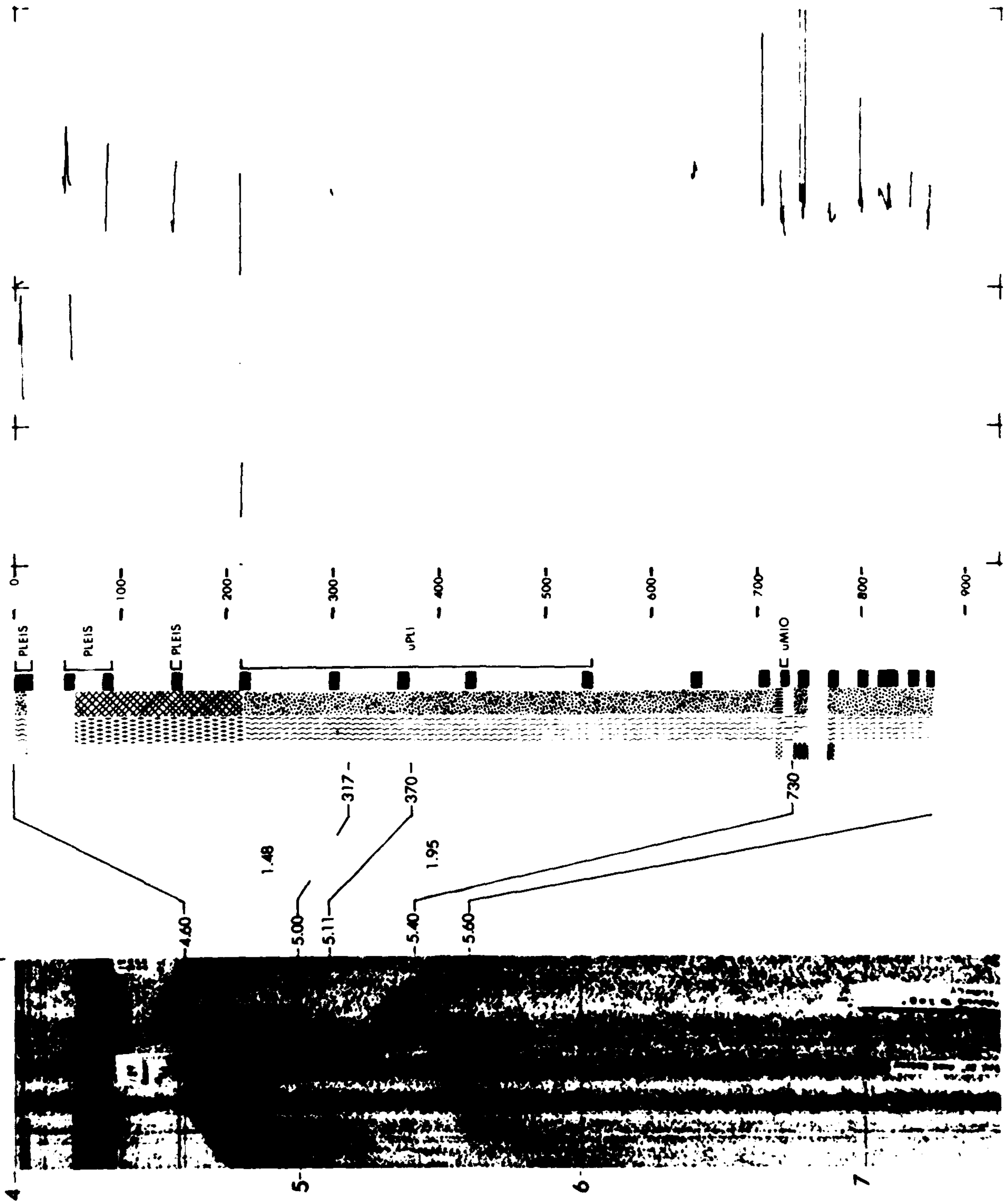
Penetration:
Drilled-- 697 meters
Cored---- 174 meters
Total---- 871 meters
Recovery:
Basement- 8 cores
28 meters
Total---- 20 cores
74 meters

The prominent acoustic basement was determined to be a deformed 20- to 40-meter thick sequence at 730 meters of size-graded sedimentary breccia and calcite-cemented sandstone of probable late Miocene age. Claystone with inclined bedding also occurs for about 100 meters above the breccia. This discovery implies that a thick apron or insular rise unit flanking the base of the Aleutian Ridge was arched after or during late Miocene time to form the Site 189 ridge. Since this time the ridge has received a thick covering of terrigenous-rich hemipelagic deposits. Uplift of the ridge, beginning shortly after the turbidite layers of sandstone and breccia were deposited, appears to coincide with a late Miocene orogenic episode that affected the length of the Aleutian Ridge. The terrigenous nature of the sedimentary section drilled at Site 189 attests to the importance of the adjacent Aleutian Ridge as a source of detrital debris. However, terrigenous debris from Kamchatka and eastern Siberia can also reach this area via a Pacific route. The uphole appearance of calcareous foraminifera and nannoplankton near the Plio-Pleistocene boundary, a phenomenon found at all other Bering Sea sites, implies a major downward shift in the carbonate compensation depth in the early Pleistocene.

Siliceous sediment; diatom rich.



SITE 189 LEG 19



SITE DATA

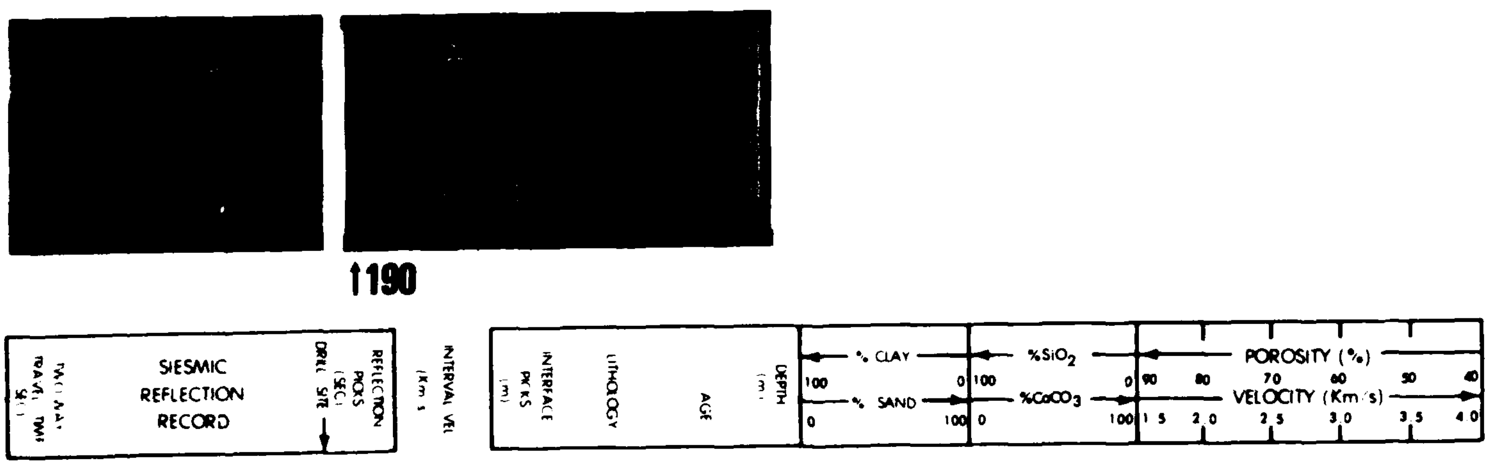
Position:
    Latitude   55° 33.5' N
    Longitude 171° 38.4' E
Date: 08/22/71
Time: 1930Z
Water depth: 3875 meters
Location: Southwestern Aleutian
        Basin

CORE DATA

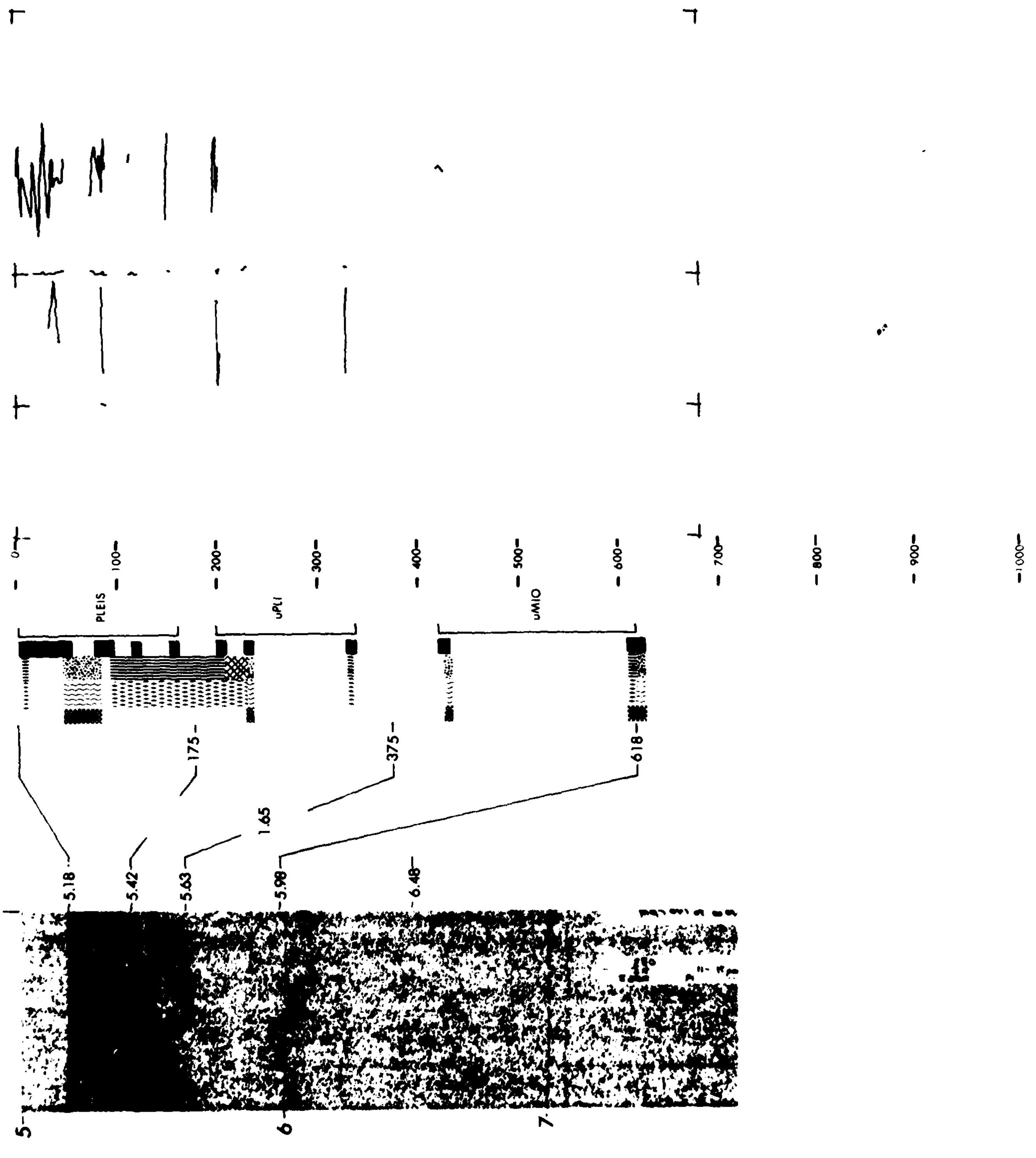
Penetration:
  Drilled-- 485 meters
  Cored---- 142 meters
  Total---- 627 meters
Recovery:
  Basement-   2 cores
              0 meters
  Total---- 16 cores
             85 meters

It can be conjectured that the leveling of the abyssal plain in the vicinity of Site 190 resulted from the deposition of only distal turbidites together with a continual rain of siliceous microorganisms. However, the fact that the site is located over a slight structural dome, across which the acoustically definable turbidite sequence thins, may have, in part, contributed to the general paucity of coarser graded sand and silt layers. Within the acoustically measured turbidite section (250 m), only the upper 175 meters contain coarse size-graded beds. Presumably this section, which corresponds to the entire Pleistocene, signifies glaciation and glacially lowered sea levels. However, displaced freshwater and littoral diatoms occur to a depth of 200 meters in upper Pliocene diatomaceous and silty beds, and acoustically the turbidite-bearing sequence extends at least 50 meters deeper. The silty diatom ooze and diatomaceous silty clay below 375 meters is worm-burrowed and semi-indurated and largely of late late Miocene age.

Siliceous sediment; diatom rich. Detrital sediment occasionally mica or serpentine rich.



SITE 190 LEG 19



SITE DATA	
Position:	
Latitude	56° 56.7' N
Longitude	168° 10.7' E
Date:	08/25/71
Time:	1030Z
Water Depth:	3854 meters
Location:	Kamchatka Basin

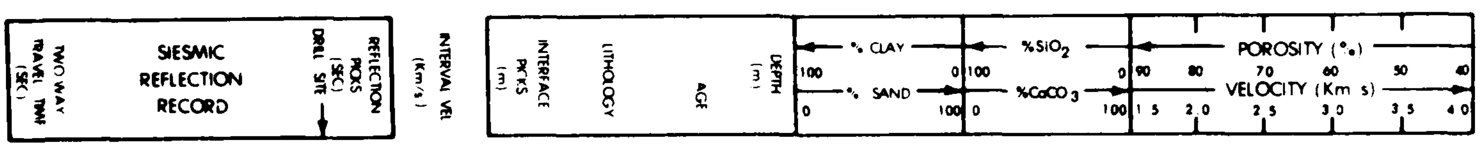
CORE DATA

Penetration:	191	191A	191B	
Drilled--	789	14	0	meters
Cored----	130	36	9	meters
Total----	919	50	9	meters
Recovery:				
Basement-		0	0	cores
	1.4	0	0	meters
Total----	16	4	1	cores
	44	21	8.5	meters

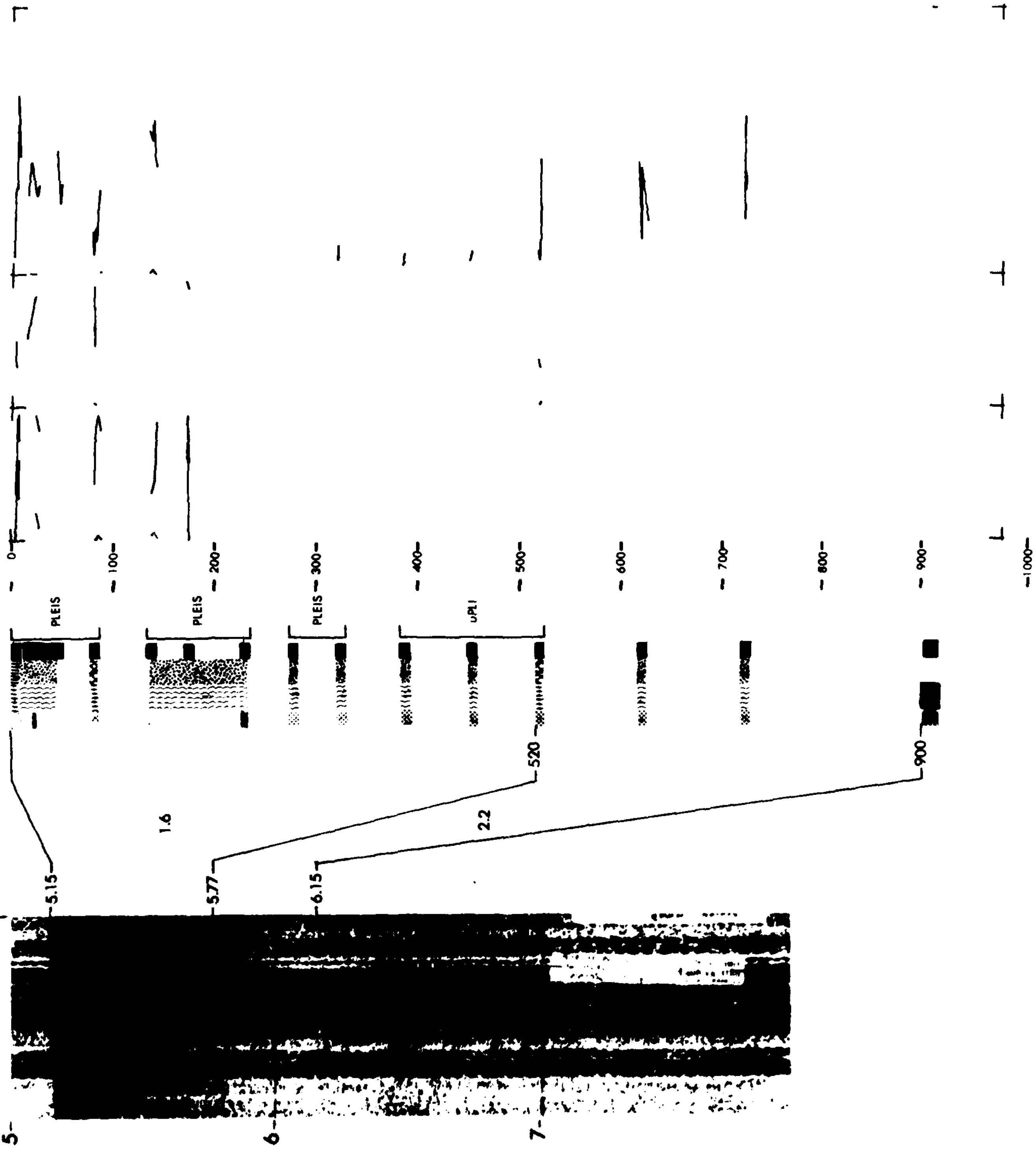
A tholeiitic or low-K basalt contained textural variation that suggests it is a submarine flow. The upper 520 meters has recognizable variations in the abundance of sand, degree of induration, and occurrence of limestone beds. Volcanic ash is present in the upper 240 meters (middle and upper Pleistocene). Reworked extinct Miocene species of diatoms and silicoflagellates, and sublittoral and freshwater diatoms are found to a depth of 520 meters throughout the Pleistocene section and into upper Pliocene beds as well. Shallow-water foraminiferal assemblages are typically associated with the sand layers. The upper 300 meters of sandy and silty deposits cored in Kamchatka Basin are rather "classically" a turbidite sequence. Size-graded layers are present as well as reworked fossils and displaced freshwater and shallow-water species. Size-graded units were not detected below 300 meters, silty clay containing displaced fresh- and shallow-water diatoms occur to 520 meters, close to the base of the turbidite sequence indicated on seismic reflection records.

Detrital, occasionally mica or serpentine rich, sediments interbedded with few thin layers siliceous sediment, diatom rich.

↑191



SITE 191 LEG 19



SITE DATA

Position:
- Latitude 53° 00.6' N
- Longitude 164° 42.8' E

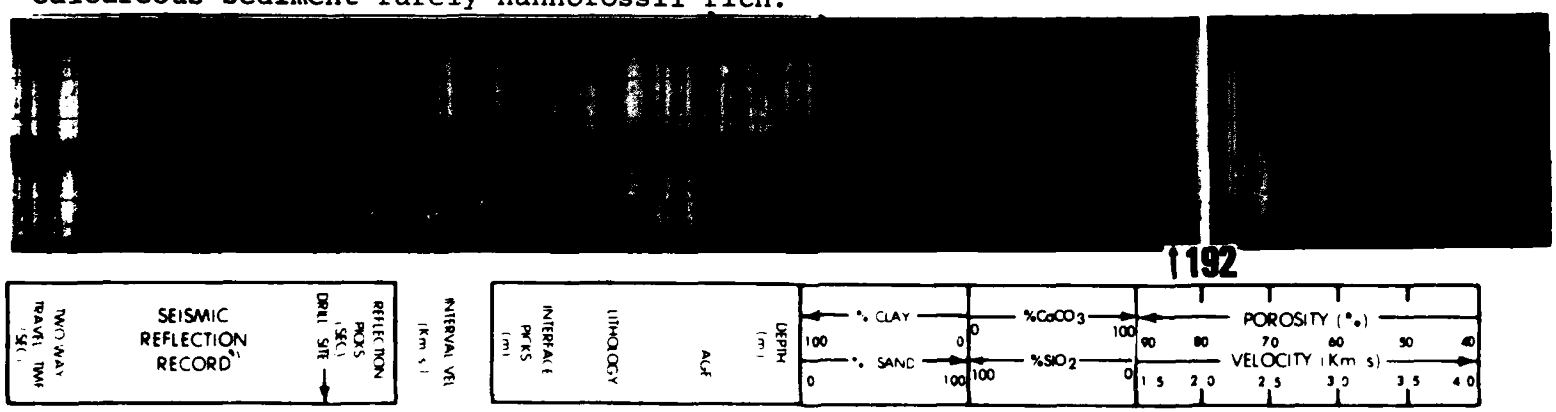
Date: 09/04/71
Time: 0400Z
Water depth: 3014 meters
Location: Meiji Guyot

CORE DATA

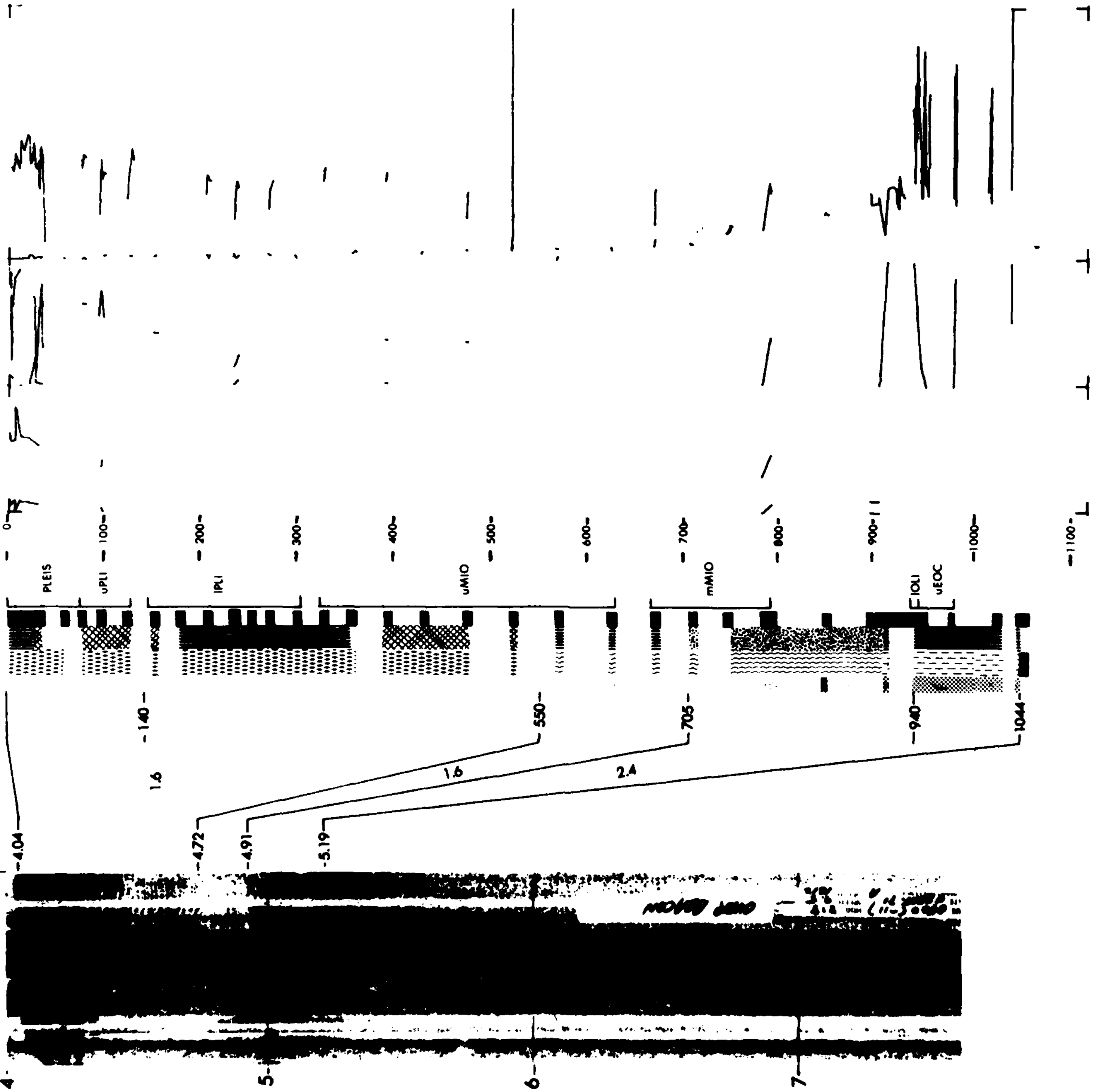
Penetration:	192	192A	
Drilled--	634	1010	meters
Cored----	308	47	meters
Total----	942	1057	meters
Recovery:			
Basement-	0	2	cores
	0	13	meters
Total----	35	6	cores
	152	38	meters

An unconfirmity separates middle Eocene and Cretaceous (middle Maestrichtian) beds. At 1044 meters the sedimentary sequence apparently depositionally overlies a complex of alkali basalt and trachybasalt flows. It is notable that abundant ice-rafted (?) debris and volcanic ash occur down to middle Pliocene deposits, although a few ash layers occur in lower Pliocene beds. Presumably this means that formation of glaciers in Kamchatka and a late Cenozoic episode of intense volcanism in the Kamchatka-Kuril region began about 3 m.y. ago. The richly diatomaceous beds, 550 meters thick, overlying the seamount attest to high fertility of the overlying surface waters back to early late Miocene time. Prior to this, and through the Oligocene, the seamount was buried beneath a nearly equally thick pile of pelagic clay. Microfauna and flora suggest that the sediment-water interface has remained near the carbonate compensation depth throughout deposition of the entire sediment section. The thick, lower Miocene to lower upper Miocene pelagic clay requires that parts of Meiji Guyot was near a sediment source at this time. The only possible source areas are Kamchatka to the west and the Aleutian Ridge to the north, which were both tectonically and volcanically active in the mid-Tertiary.

Interbedded detrital sediment and siliceous, diatom rich, sediment. Earlier calcareous sediment rarely nannofossil rich.



SITE 192 LEG 19



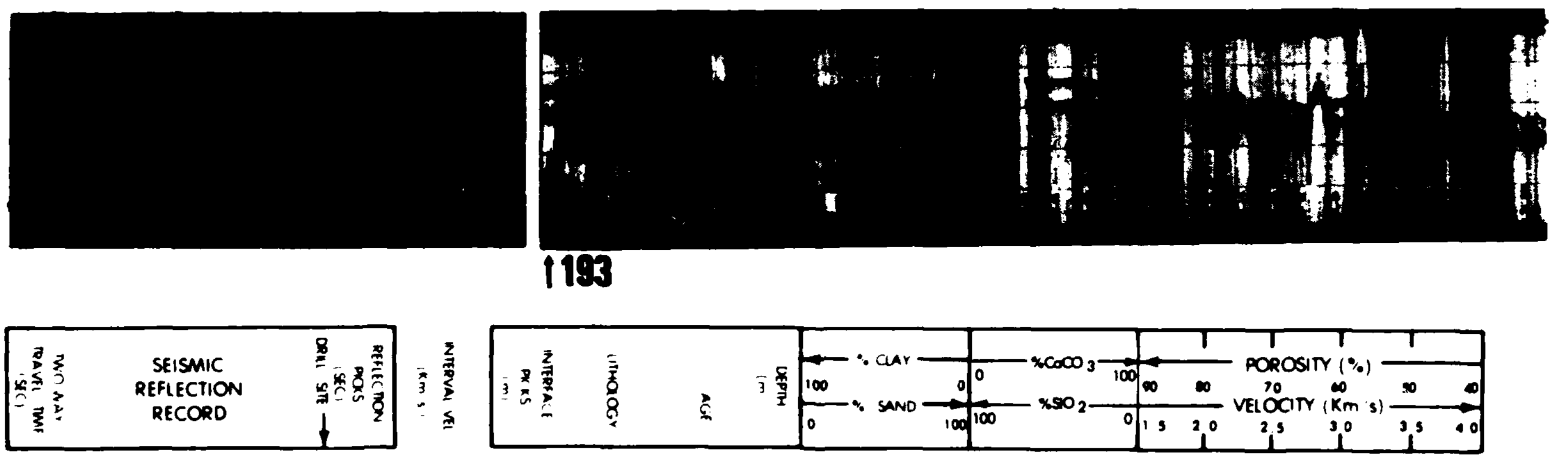
SITE DATA

Position:
Latitude $45^\circ 48.2'$ N
Longitude $155^\circ 52.3'$ E
Date: 09/06/71
Time: 2153Z
Water depth: 4811 meters
Location: Hokkaido Rise

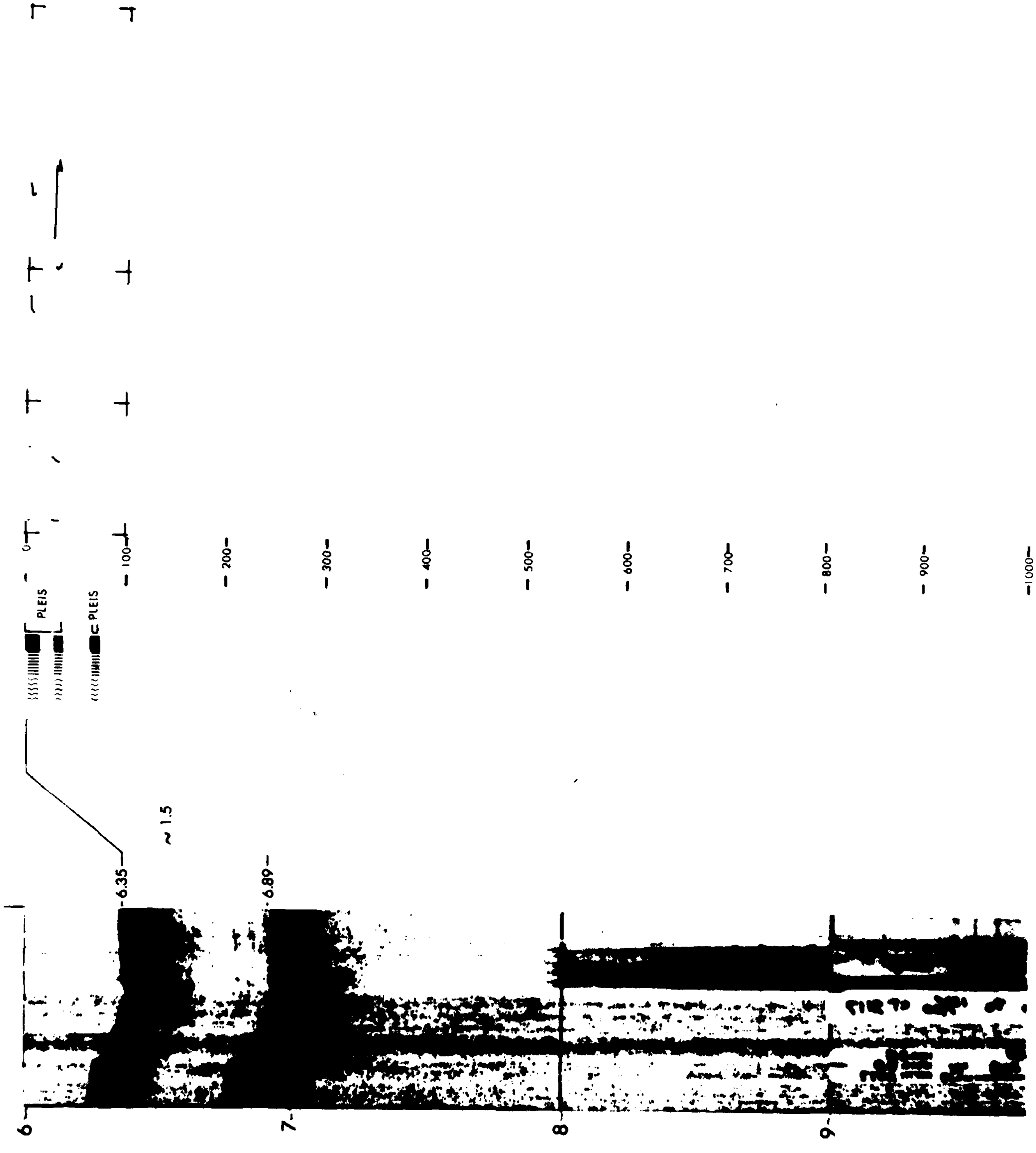
CORE DATA

Penetration:
Drilled-- 42 meters
Cored---- 29 meters
Total---- 71 meters
Recovery:
Basement- 0 cores
0 meters
Total---- 4 cores
12 meters

The entire section is high in volcanic glass and terrigenous silt content, probably pyroclastic and terrigenous debris supplied by the Japanese and Kuril islands. Although we have only spotty recovery, discrete ash units may be more numerous in the upper part of the section. Hays and Ninkovich (1970) state that Northwest Pacific ashes, from Kamchatka and the Kuril Islands, are light in color and composed of colorless shards, while the Aleutians supply both dark and light-colored ashes to the Northeast Pacific. The ashes at Site 193 are dark in color as they appear in the core, but the shards themselves are colorless. The color of the ash as seen in the core is due to contained opaques plus the fact that the shards are being altered to clay. Cores 1 and 2 are richer in diatoms than are Cores 3 and 4. The overall low rate of Pleistocene sedimentation at Site 193 indicates this may be due more to a fluctuation in diatom productivity than to a change in rate of supply of terrigenous components.



SITE 193 LEG 19



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Deep ocean sediment cores recovered by the drill ship D/V GLOMAR CHALLENGER have provided invaluable "boundary conditions" for the interpretation of marine seismic reflection and refraction data. In combination, these data provide much of the basis for constructing geoacoustic models in support of low-frequency acoustic propagation in the deep ocean. This report provides a concise, graphic correlation between vertical reflection seismic records across the drill holes,and lithologic-physical property data measured from

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the drilled cores. This correlation and condensation in a standardized format is the first step in producing a synthesis of the data, which will provide insight into the correlation between lithologic and acoustic properties of marine sediments. As stated, this data presentation is only the first step of a synthesis, and interpretation has been minimized. The material is being published at this time in the belief that the condensed data presentation is of immediate value to many people independent of the authors' ultimate objective. A detailed discussion of terminology and measurement technique is provided for users from outside the geoscience discipline.

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